Ambient Air Quality Draft Modeling Protocol and Impact Analysis

Dewey-Burdock Project

Powertech (USA) Inc.

Edgemont, South Dakota

June 12, 2013

Prepared by:

IML Air Science

a division of Inter-Mountain Laboratories, Inc.

555 Absaraka

Sheridan, Wyoming 82801

(307) 674-7506

www.imlairscience.com

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

Define acronyms

1 INTRODUCTION

Powertech (USA) Inc. (Powertech) has proposed to construct an in-situ recovery (ISR) uranium facility at the Dewey-Burdock site in southwestern South Dakota. An assessment of the air quality impacts of the proposed facility is required as part of the NRC license application and Supplemental Environmental Impact Study (SEIS). Powertech enlisted IML Air Science to develop a project emissions inventory and to model the impacts of these emissions on ambient air quality. IML was also asked to assess potential project impacts on Air Quality Related Values (AQRV's) at the nearby Wind Cave National Park, a Class I area.

The air quality modeling protocol is presented in Sections 2 through 5. It addresses the approach for assessing the ambient air quality impacts from the proposed source emissions for comparison with the National Ambient Air Quality Standards (NAAQS) for PM_{10}, $PM_{2.5}$, CO, SO_2 and NO_2. It also addresses the approach for comparing modeled project impacts to the Prevention of Significant Deterioration (PSD) increments for PM_{10}, $PM_{2.5}$, SO_2 and NO_2. Finally, the protocol establishes the methods and assumptions used to model impacts on AQRV's, including visibility and deposition impacts, at Wind Cave National Park.

Mention that GHG emissions are estimated and presented but are not modeled.

The modeling results and ana in Sections 6 and 7. Section 6 contains the ambient air qual nd Section 7 contains the AQRV analysis. Details concerning potential project emissions, modeling assumptions and parameter settings, and model outputs appear in Appendix A through Appendix ~~F~~ to this document.

1.1. Project Overview

The proposed Dewey-Burdock Project is a uranium in-situ recovery (ISR) facility in Custer and Fall River counties, South Dakota. The facility is composed of well fields, a central processing plant, and a satellite processing plant. The project will entail four phases: construction, operation, aquifer restoration and decommissioning. The construction phase will be further partitioned into a facilities construction phase and a well field construction phase. Fugitive emission sources of particulate matter (PM_{10}, $PM_{2.5}$) include construction and drilling activities, wind erosion, product transport, pickup traffic, delivery trucks, and passenger vehicles. Particulates (PM_{10}, $PM_{2.5}$), carbon monoxide (CO), and oxides of nitrogen and sulfur (NO_x and SO_2) will be emitted by mobile equipment engine exhaust and by stationary sources such as heaters, pumps, emergency generators and a thermal dryer.

1.2. Modeling Overview

The original emissions inventory calculations and dispersion modeling results for the Dewey-Burdock Project were submitted to NRC in 2009. Based on direction from NRC and EPA several corrections and refinements to the emissions inventory were made and published in the SEIS Draft Report in November of 2012. The agencies also requested a more comprehensive modeling analysis to include both fugitive dust and combustion emission sources, to characterize timing of the emissions, to model all inventoried pollutants, and to analyze AQRV impacts at Wind Cave National Park. The revised emissions were modeled in accordance with these requests; the associated modeling protocol and results were published in February 2013. Additional comments submitted by NRC and EPA, as well as South Dakota Department of Natural Resources (DENR) and the Bureau of Land Management (BLM), prompted further refinements to the emissions inventory and modeling protocol. Based on these refinements, final modeling runs were completed in June of 2013. This document presents the final modeling protocol and model predictions.

1.3. Document Overview

This document addresses two separate modeling scenarios: (1) modeling for ambient air quality impacts at the project boundary, at locations within 50 km of the project, and at Wind Cave National Park (a Class I area), and (2) modeling for AQRV impacts, including visibility and atmospheric deposition impacts, at Wind Cave National Park. Since these two scenarios utilize different modeling assumptions, domains, software models, and meteorological data sets, they are addressed separately.

Ambient air quality impact analysis will be performed using the AERMOD dispersion model. Sections 3 and 4 of this document apply to the AERMOD modeling protocol. AQRV impact analysis will be performed using the CALPUFF model. Section 5 applies to the CALMET/CALPUFF modeling protocol. Section 2 discusses project related emissions and modeled emission sources, which apply equally to AERMOD and CALPUFF.

1.4. Pollutants of Concern

Both combustion emissions and fugitive dust emissions will be modeled in the air quality and AQRV impact analyses. The stationary and fugitive emission sources at the Dewey-Burdock Project will produce particulate matter smaller than ten microns in size (PM_{10}) and particulate matter smaller than 2.5 microns in size ($PM_{2.5}$). Stationary and mobile sources will emit PM_{10}, $PM_{2.5}$, carbon monoxide (CO), sulfur dioxide (SO_2) and oxides of nitrogen (NO_x). For the AERMOD analysis it is assumed that 75% of NO_x emissions will be converted to NO_2. This assumed conversion is not necessary for CALPUFF, since it models atmospheric chemistry inherently. Thus, five criteria pollutants (PM_{10}, $PM_{2.5}$, CO, SO_2 and NO_2) will be analyzed for compliance with the NAAQS. Four of these pollutants, PM_{10}, $PM_{2.5}$, SO_2 and NO_2 will be further analyzed for comparison with the PSD increments in Class I and Class II areas. This comparison will be made for disclosure purposes only, since Dewey-Burdock does not qualify as a PSD source.

Both the NAAQS and the PSD analyses will be conducted using the AERMOD software. The modeling domain for AERMOD will extend roughly 50 km in all directions from the Dewey-Burdock Project. Modeled impacts within this domain will be compared to the NAAQS and Class II PSD increments. Since Wind Cave National Park is roughly 50 km from the project site, the Wind Cave park boundary will be included in the air quality impact analysis. Modeled impacts at Wind Cave will be compared to the NAAQS and PSD Class I increments.

These same pollutants have the potential to impact visibility at Wind Cave National Park. Moreover, SO_2 and NO_2 emissions may affect atmospheric deposition. For these reasons an AQRV analysis will be conducted using the CALMET/CALPUFF software. The modeling domain for CALPUFF will extend 100 km in all directions from the Dewey-Burdock Project to provide a 50-km buffer for the Wind Cave Class I area AQRV impact analysis.

1.5. Regulatory Status

The Dewey-Burdock Project will be a non-categorical stationary source. Criteria pollutant emissions from the facility will be below the New Source Review major source threshold of 250 tons/year. Therefore, the facility will not be subject to PSD permitting regulations. The potential to emit hazardous air pollutants (HAPs) will be less than 10 tons/year for any individual HAP, and less than 25 tons/year for all HAPs combined.

Therefore, the facility will not be a major HAP source. Point source emissions of criteria pollutants from the facility will be less than the Title V source threshold of 100 tons per year.

1.6. Results Summary

The modeling results presented in Section 6 predict compliance with all NAAQS ~~levels~~, with one qualification. With the regulatory default options ~~selected, AERMOD predicted values greater than the PM_{10} 24-hr standard at three model receptors less than 200 meters from the public road. With~~ a background of 41 μg/m^3 added to the project impacts, this initial model run predicted ~~values~~ greater than the PM_{10} 24-hr standard at 50 receptors (all located within a few hundred meters of the public road or project boundary). AERMOD was re-run for these 50 receptors with the dry depletion option selected to account for PM_{10} particle deposition and corresponding plume depletion. This refined analysis predicted all receptors to be in compliance with the PM_{10} 24-hr standard when adding project impacts to the background concentration. Since Dewey-Burdock is the first ISR project for which extensive modeling has been required, there is no basis for direct comparison of these modeling results to similar projects.

Please do not u
word "complian
conjunction wit
increments. Th
a PSD regulato
analysis. Thus
"compliance" is
wrong word.

The modeling results also predict ~~compliance with all~~ PSD Class I and Class II increments, with the exception of 24-hour PM_{10} impacts near the project. The refined PM_{10} analysis ~~showed impacts~~ above the Class II increment of 30 μg/m^3 at receptors that fall within a narrow corridor along the public road and the northwestern portion of the project boundary. At a distance of 500 meters or more from the project boundary and the public road, all modeled concentrations were below the PSD Class II increment.

AQRVs is plu
not possessiv

CALPUFF predicted impacts on AQRV's at Wind Cave National Park that are below the applicable thresholds. Maximum 3-year deposition rates for sulfur and nitrogen were below the respective concern thresholds by an order of magnitude. Visibility impacts were quantified as the 98th percentile of the 24-hour change in haze index, measured in deciviews (dv). Using this definition and selecting the conservative modeling assumption that coarse particulates can influence visibility 50 km away from the source, the highest-impact receptor showed a change of 0.35 dv. The threshold for contribution to visibility impairment is 0.5 dv.

I realize that the main point of this document is to support and explain modeling. However, it would be useful to include a brief paragraph or two on greenhouse gas emission estimation methods, total GHG emissions, and an explanation that there are no NAAQS for GHGs or modeling for GHG emission impacts.

2 EMISSION AND S

2.1. Facility Processes and Emission Controls Affected

The ~~nature of the~~ proposed facility ~~is to~~ extract uranium oxide in solution from uranium bearing formations using in-situ recovery. The solution is processed at on-site facilities to recover yellow cake for transport to an off-site refining facility. Facility processes and emission controls planned for the Dewey-Burdock Project include the use of a dust suppressant to control fugitive dust emissions from unpaved roads, a vacuum dryer to eliminate yellow cake dust generation, and standard diesel engine controls to minimize tailpipe emissions.

2.2. Emission Factors Used to Calculate Potential Emissions

The Dewey-Burdock Project will generate both on-site and off-site emissions. On-site emissions will include stationary source, fugitive dust and tailpipe emissions occurring within the project boundary. Off-site emissions related to the project will be associated with vehicle traffic accessing the project by an unpaved county road. The off-site emissions inventory will include fugitive dust from the road and combustion emissions from vehicle tailpipes. Both on-site and off-site sources will be modeled for ambient air quality and AQRV impacts.

In general, fugitive dust emissions from the Dewey-Burdock Project will include traffic on unpaved roads, drilling and earth moving activities, road maintenance, topsoil stripping and reclamation, and wind erosion on disturbed areas. Emission factors for these sources are provided in EPA's AP-42, Compilation of Air Pollutant Emission Factors as listed below (EPA 1995c):

- Unpaved roads — Chapter 13, Section 13.2.2
- Drilling and earth moving — Chapter 11, Section 11.9, Table 11.9-4
- Topsoil stripping and reclamation — Chapter 11, Section 11.9, Table 11.9-4
- Wind erosion — Chapter 11, Section 11.9, Table 11.9-4

In some cases fugitive $PM_{2.5}$ emission factors were not available in AP-42. For wind erosion, a $PM_{2.5}$/ PM_{10} ratio of 15% was applied to the respective PM_{10} emission factor. For unpaved road dust, a $PM_{2.5}$/ PM_{10} ratio of 10% was applied to the respective PM_{10}

emission factor. These ratios follow recommendations in a study performed for the Western Regional Air Partnership (WRAP) by Midwest Research Institute (MRI 2006).

Published fugitive dust emission factors are modified by specific control measures. EPA guidance provided in AP-42 allows for natural mitigation of fugitive dust emissions based on days of precipitation per year (page 13.2.2-7, Equation 2). Figure 13.2.2-1 in AP-42 shows a contour plot of days per year with precipitation greater than or equal to 0.01" (wet days). For the Dewey-Burdock Project area this value is 90 days per year, and applies to all unpaved roads (on-site and off-site). Guidance also typically allows for 50% control efficiency with the use of water trucks for dust suppression on unpaved roads. For the Dewey-Burdock Project, the number of water trucks and frequency of water application justify a higher control efficiency, as supported in Appendix D. In this case, a control efficiency of 60% will be used for on-site roads. For the purpose of calculating fugitive dust emissions, no control will be assumed for the public road.

Please define

Gasoline and diesel equipment tailpipe emissions were calculated using emission factors from several sources. THC, SO_2, CO_2 and aldehyde emission factors were taken from AP-42 Chapter 3, Table 3.3-1. NO_x, CO, and PM_{10} emission factors for diesel engines are based on EPA standards for various engine tier ratings (EPA 1998). Drill rigs were assumed to have Tier 1 engines, while all other mobile diesel equipment was assumed to conform to Tier 3 standards. The THC emission factor for Tier 1 diesel engines was used for drill rigs, in place of AP-42. $PM_{2.5}$ emissions from equipment tailpipes were assumed to be 97% of PM_{10} emissions (EPA 2004a). Emission factors for propane fired heaters and emergency generators were obtained from AP-42, Table 1.5-1 (EPA 1995c). Emission factors for diesel pumps were taken from AP-42, Table 3.3-1 (EPA 1995c).

Do you mean CO?

2.3. Schedule of Fugitive Particulate Emissions

The potential fugitive emission rates from the Dewey-Burdock Project are summarized in Table 2-1. Detailed emission calculations for the proposed project have been provided in Appendix A. The basis for timing and the source apportionment of equipment-generated fugitive emissions are presented in Appendix B. Year 7 will be modeled since it shows the highest total for fugitive dust emissions. Table 2-1shows that during year 7 four phases are expected to be active, including well field construction, operation, restoration and decommissioning. Both on-site and off-site, project related fugitive dust emissions will be modeled for NAAQS, PSD and AQRV impacts.

Table 2-1: Potential Fugitive Emissions by Year (tons/year)

SCHEDULE		ON-SITE FUGITIVE EMISSIONS (INCLUDING WIND EROSION)		OFF-SITE FUGITIVE EMISSIONS	
Year	Phases	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
1	CF	225.91	24.15	56.91	5.69
2	CW, O	284.49	30.00	69.18	6.92
3	CW, O	284.90	30.06	69.18	6.92
4	CW, O, R	293.01	30.89	75.43	7.54
5	CW, O, R	293.42	30.95	75.43	7.54
6	CW, O, R	293.75	31.00	75.43	7.54
7	CW, O, R, D	354.19	37.06	103.80	10.38
8	CW, O, R, D	352.38	36.79	103.80	10.38
9	O, R, D	198.93	21.41	76.50	7.65
10	R, D	97.99	11.31	34.62	3.46
11	D	90.20	10.52	28.37	2.84
12	D	90.12	10.51	28.37	2.84
13	D	90.09	10.51	28.37	2.84
14	D	90.08	10.51	28.37	2.84

CF = Construction of Facilities
CW = Construction of Wellfields
O = Operation
R = Restoration
D = Decommissioning and Reclamation

2.4. Schedule of Tailpipe Emissions

Table 2-2 summarizes potential combustion emissions from equipment tailpipes. As with fugitive emissions, the highest annual tailpipe emissions of PM_{10}, $PM_{2.5}$, CO, SO_2 and NO_x are projected for year 7. Detailed emission calculations for the proposed project have been provided in Appendix A. The basis for timing of tailpipe emissions is presented in Appendix B. Year 7 will be modeled since it shows the highest total emissions. Both on-site and off-site, project related tailpipe emissions are represented in Table 2-2 and will be modeled for NAAQS, PSD and AQRV impacts.

Table 2-2: Potential Tailpipe Emissions by Year

Mobile Engine Combustion Emissions (tons/year)					
	NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO
Year 1	51.08	2.97	2.88	8.58	49.05
Year 2	54.82	3.17	3.07	9.03	51.01
Year 3	54.82	3.17	3.07	9.03	51.01
Year 4	56.05	3.25	3.15	9.10	51.79
Year 5	56.05	3.25	3.15	9.10	51.79
Year 6	56.05	3.25	3.15	9.10	51.79
Year 7	68.46	3.87	3.75	11.31	58.90
Year 8	68.46	3.87	3.75	11.31	58.90
Year 9	27.54	1.51	1.47	4.26	17.20
Year 10	13.64	0.70	0.68	2.27	7.89
Year 11	12.41	0.62	0.60	2.21	7.11
Year 12	12.41	0.62	0.60	2.21	7.11
Year 13	12.41	0.62	0.60	2.21	7.11
Year 14	12.41	0.62	0.60	2.21	7.11

For purposes of modeling in AERMOD, NO_x emissions will be multiplied by 0.75 to estimate NO_2 emissions. NO_2 is the regulated pollutant, with associated NAAQS and PSD increments, per Section 6.2.3 of EPA's Guideline on Air Quality Models (40 CFR 51 Appendix W).

2.5. Stationary Equipment Emissions

Table 2-3 summarizes stationary equipment emissions. With the exception of startup construction, these emissions are assumed to be constant from year to year.

Table 2-3: Potential Stationary Equipment Emissions per Year

Stationary Equipment Emissions (tons/yr)					
Pollutant	**Space Heater**	**Dryer Thermal Fluid Heater**	**Emergency Generator**	**Pump**	**Total**
NO_x	0.74	0.91	0.00	0.04	1.69
PM10/PM2.5	0.040	0.049	0.000	0.003	0.092
SO_2	0.001	0.001	0.000	0.003	0.005
CO	0.43	0.52	0.00	0.01	0.96

2.6. Source Parameters

The modeled emission sources in AERMOD will include area sources, line-area sources and point sources. The line-area sources include the haul road, access roads and public road. Area sources include disturbed acreage, well fields, reclamation areas, and plant facilities. AERMOD release heights for area and line-area sources of fugitive dust will follow recent EPA guidance (EPA 2012) assuming average vehicle heights are 3.0 meters for project roads and well fields, and 2.0 meters for the public road. Based on this guidance, release heights for 3-meter and 2-meter vehicle heights are 2.55 and 1.70 meters, respectively. Corresponding sigma-Z values are 2.37 and 1.58 meters, respectively. For those sources dominated by wind erosion (e.g. land application and facilities areas), release heights are assumed to be 1 foot and sigma-Z is assumed to be zero. Release heights for equipment tailpipe emissions are assumed to be 1 meter, with a sizma-Z of zero.

For CALPUFF modeling, the point, area and line-area sources will be identical to those used for AERMOD, with one exception. Since CALPUFF models multiple pollutants simultaneously (fugitive dust and gaseous emissions), uniform release heights and sigma-Z values of 1.0 meters will be used for all area and line-area sources.

Appendix B details the apportionment of equipment and fugitive emissions among these sources. Based on this apportionment process, Table 2-4 summarizes area and line-area source emissions (tons/year), including both on-site and off-site emissions.

Table 2-4: Year 7 Area and Line-Area Source Emission Totals

Area/Line Source Totals	PM_{10}	$PM_{2.5}$	NO_x	SO_2	CO
Disturbed	164.88	18.52	16.62	2.15	11.67
AccessRdSat	10.53	1.08	0.72	0.21	0.61
AccessRdCPP	21.13	2.18	1.45	0.43	1.24
NewWells	73.27	8.82	30.18	5.18	34.86
FacilitiesCPP	5.70	0.85	4.62	0.36	1.27
FacilitiesSat	2.85	0.42	2.24	0.17	0.55
HaulRd	6.10	0.64	0.59	0.18	0.51
OperWells	20.01	2.09	1.96	0.61	1.70
DecomWells	43.50	4.58	7.30	1.59	4.49
LandAPDewey	5.35	0.80			
LandAPBurdock	4.57	0.68			
AccessRdPublic	103.96	10.54	2.78	0.42	2.00
Year 7 Totals (tpy)	**461.86**	**51.20**	**68.46**	**11.31**	**58.90**

Table 2-5 summarizes point source emission rates (tons/year) and associated stack parameters for the modeled year. All modeled point sources have a vertical discharge. The modeled CPP heater source includes multiple space heaters located within the main facility.

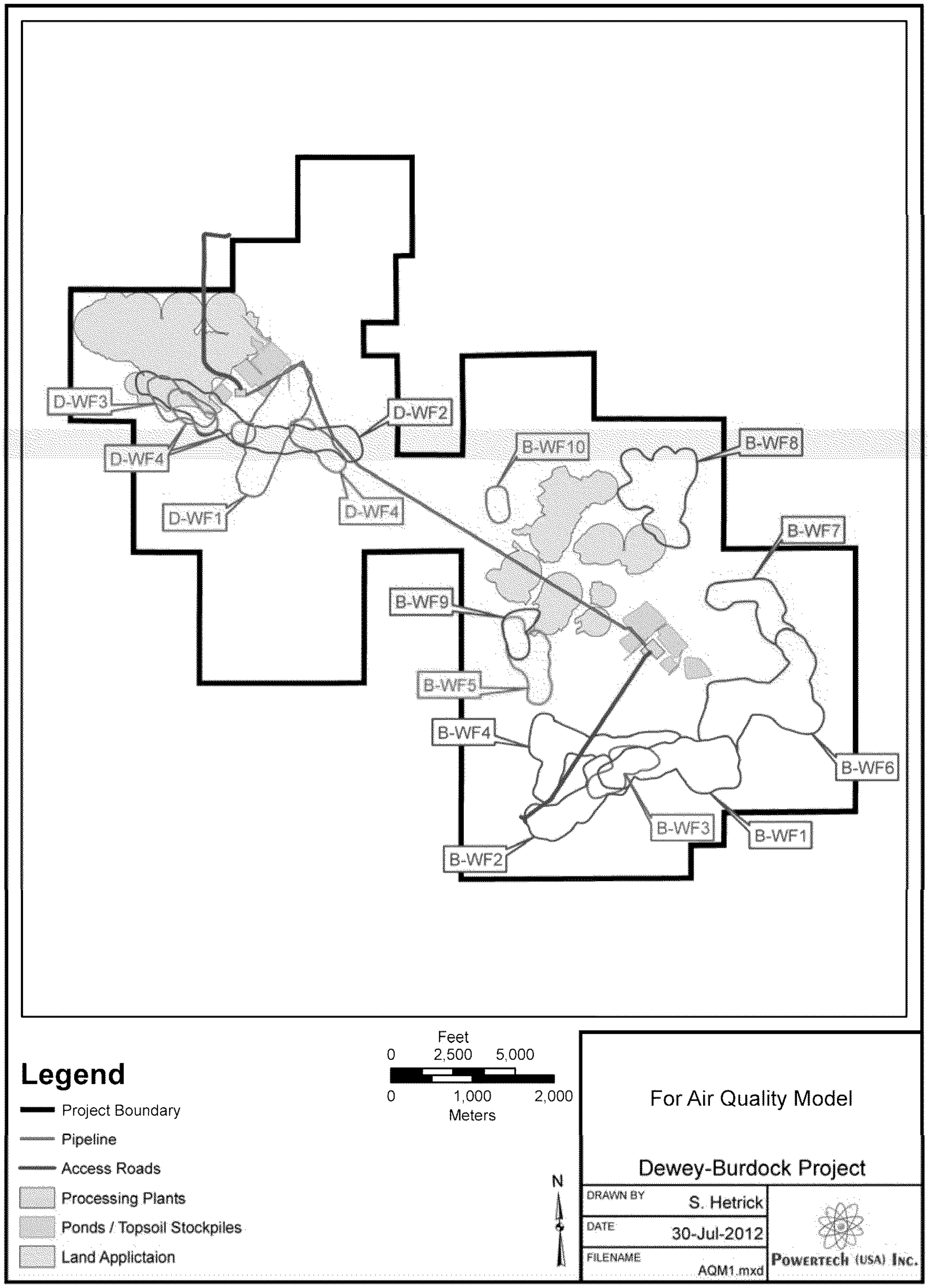
Should stack heights be added to this table?

Table 2-5: Point Source Emission Totals and Stac

	Emissions (tons/year)					**Stack**	**Temp**	**Velocity**
Point Source Totals	PM_{10}	$PM_{2.5}$	NO_x	SO_2	CO	Diam (in)	(Deg F)	(ft/sec)
CPP_Point_Dryer	0.049	0.049	0.909	0.001	0.524	9.0	200	17.4
CPP_Point_Heater	0.020	0.020	0.369	0.000	0.213	5.0	160	5.4
CPP_Point_Pump	0.001	0.001	0.020	0.001	0.004	4.0	240	27.2
Sat_Point_Heater	0.020	0.020	0.369	0.000	0.213	5.0	160	5.4
Sat_Point_Pump	0.001	0.001	0.020	0.001	0.004	4.0	240	27.2
Year 7 totals (tpy)	**0.092**	**0.092**	**1.687**	**0.005**	**0.959**			

Figure 2-1 shows the locations and orientations of modeled area and line-area sources for the Dewey-Burdock Project. Area sources will be digitized as rectangles and polygons to reduce model complexity and execution time. Modeled point sources reside at the processing plants, which include a satellite plant in the northwestern portion of the project area, and the central processing plant in the southeastern portion of the project area. Roads will be modeled as line-area sources. Not shown in Figure 2-1 is the unpaved section of county road providing access to the project site. Fugitive dust and tailpipe emissions from this road will also be modeled.

Figure 2-1: Dewey-Burdock Project Emission Source Locations



Is something missing here? "AERMOD" is not associated with a sentence.

Source emission rates will be assumed to be uniform during the time each source is active, but variable throughout the modeled year based on equipment duty cycles. AERMOD For point sources, average emission rates in tons/year will be converted to lbs/hour for the hours each source is operated. For area and line-area sources, average emission rates of tons/year will be converted to lbs/hour/ft^2 for the hours each source is active and the area over which the source emissions are distributed. Line-area sources in AERMOD and CALPUFF are actually rectangular areas chained together in a prescribed line.

Appendix B presents the method used to derive variable emission rates for non-continuous emission sources. Tables B-4 and B-5 in Appendix B show the assumed timing of emissions for AERMOD and CALPUFF, respectively. These tables differ slightly because AERMOD allows greater flexibility and higher resolution in specifying the timing of emissions.

3 AMBIENT AIR QUALITY IMPACT MODELING METHODOLOGY

3.1. Model Selection and Justification

The proposed facility includes multiple sources, including point, line-area and area sources that have a wide range of parameters that are too complex to merge into a single emission point. Therefore, criteria pollutant emissions will be modeled with the American Meteorological Society (AMS) and EPA Regulatory model (AERMOD) Version 12345 to evaluate air dispersion from multiple sources. AERMOD was chosen over the Industrial Source Complex (ISC3) model since it has been promulgated by the EPA as the preferred air dispersion model in the Agency's "Guideline on Air Quality Models" (40 CFR 51 Appendix W). AERMOD officially replaced the ISC3 air dispersion model effective December 9, 2006 (one year after rule promulgation) as published in the Federal Register on November 9, 2005. The Lakes Environmental software will be used to implement the AERMOD model (Lakes AERMOD View Version 8.2.0).

3.2. Model Options

The AERMOD regulatory settings will be left in the default settings with two exceptions. First, the plume volume molar ratio method will be used to estimate the influence of atmospheric ozone on NO_2 conversion (EPA 2004b). Second, for modeling short-term PM_{10} impacts, the dry depletion option will be evaluated and compared to the default setting (no dry depletion). Section 3.9 below discusses the basis for modeling fugitive dust emissions using dry depletion. Table 3-1 summarizes the non-default settings used for AERMOD.

Table 3-1: Non-Default Settings in AERMOD

NON-DEFAULT OPTION	PURPOSE	MODELING SCENARIO
PVMRM	Modeling NO_2 with ozone	All averaging intervals for NO_2
Dry Depletion	Account for particle deposition	Refined PM_{10} 24-hr analysis

3.3. Averaging Periods

For the purpose of this modeling analysis, the annual and 24-hour averaging periods will be utilized for PM_{10} and $PM_{2.5}$ modeling. The 8-hour and 1-hour averaging periods will be used for CO modeling. The annual and 1-hour averaging periods will be used for NO_2 while the annual, 24-hour, 3-hour and 1-hour averaging periods will be used for

Do not use the word "standards" with PSD in text or tables.

SO_2 modeling. These averaging periods are consistent with the NAAQS primary and secondary standards and the PSD increment ~~standards~~. All short-term model results will be presented in the format of the appropriate standard. These include: (a) 4th high 24-hour PM_{10} value over three years, (b) 3-year average of yearly 98th percentile, or 8th high 24-hour $PM_{2.5}$ values, (c) 3-year average of yearly 98th percentile, or 8th high 1-hour NO_2 values, (d) 3-year average of yearly 99th percentile, or 4th high 1-hour SO_2 values.

3.4. Building Downwash

Based on the proposed facility design, buildings and/or structures will cause negligible influences on normal atmospheric flow in the immediate vicinity of the emission sources. Therefore building downwash will not be modeled.

3.5. Elevation Data

The terrain surrounding the Dewey-Burdock Project is relatively flat. However, the terrain encompassing model receptors includes hills and valleys. Therefore, the Elevated Terrain mode will be used. Receptor elevations will be entered based on elevations obtained from USGS digital elevation model (DEM) files.

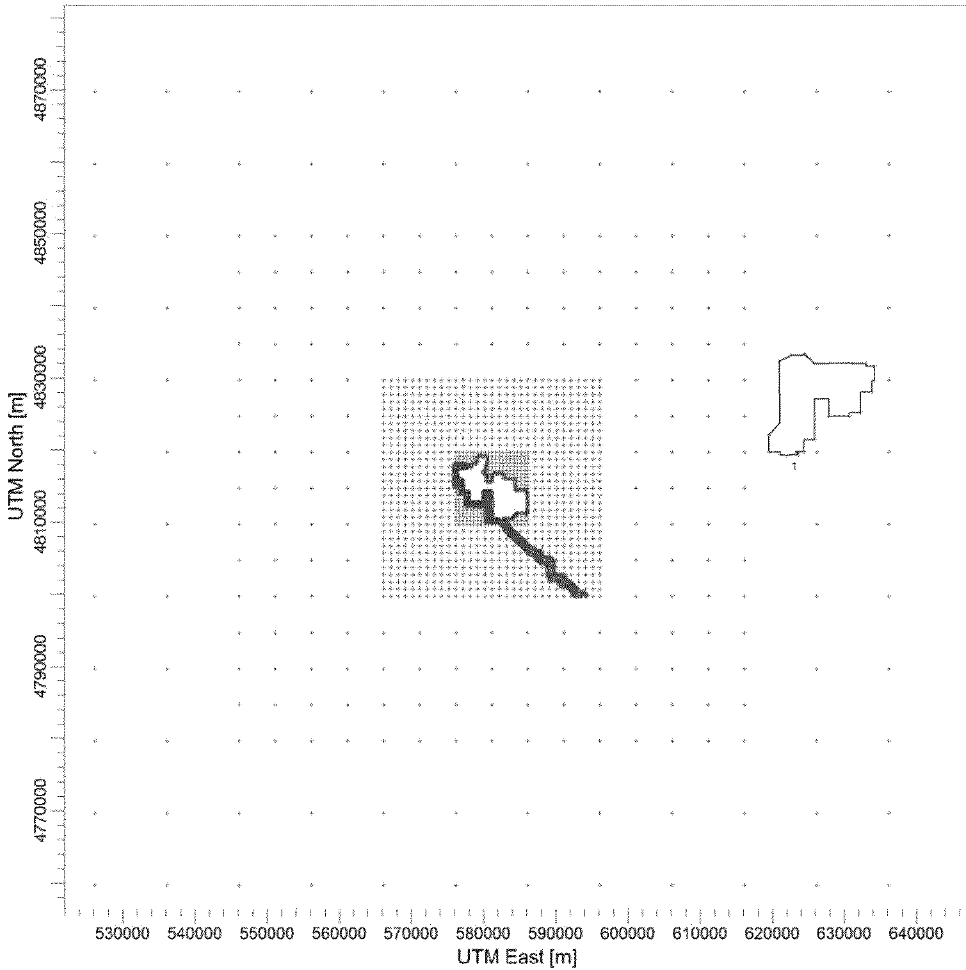
3.6. Receptor Network

Figure 3-1 displays the AERMOD receptor placement (designated as green crosses on the map). The model domain includes a total of 4,220 receptors, including fenceline, hot spot grid, intermediate grid and coarse grid receptors. The receptor grid extends in all directions from the project site to fully encompass the nearest Class I area, Wind Cave National Park, roughly 50 km from the project site. Figure 3-2 shows the AERMOD receptor locations in the vicinity of the Dewey-Burdock Project. The receptor network is described below.

3.6.1. Fenceline Receptors

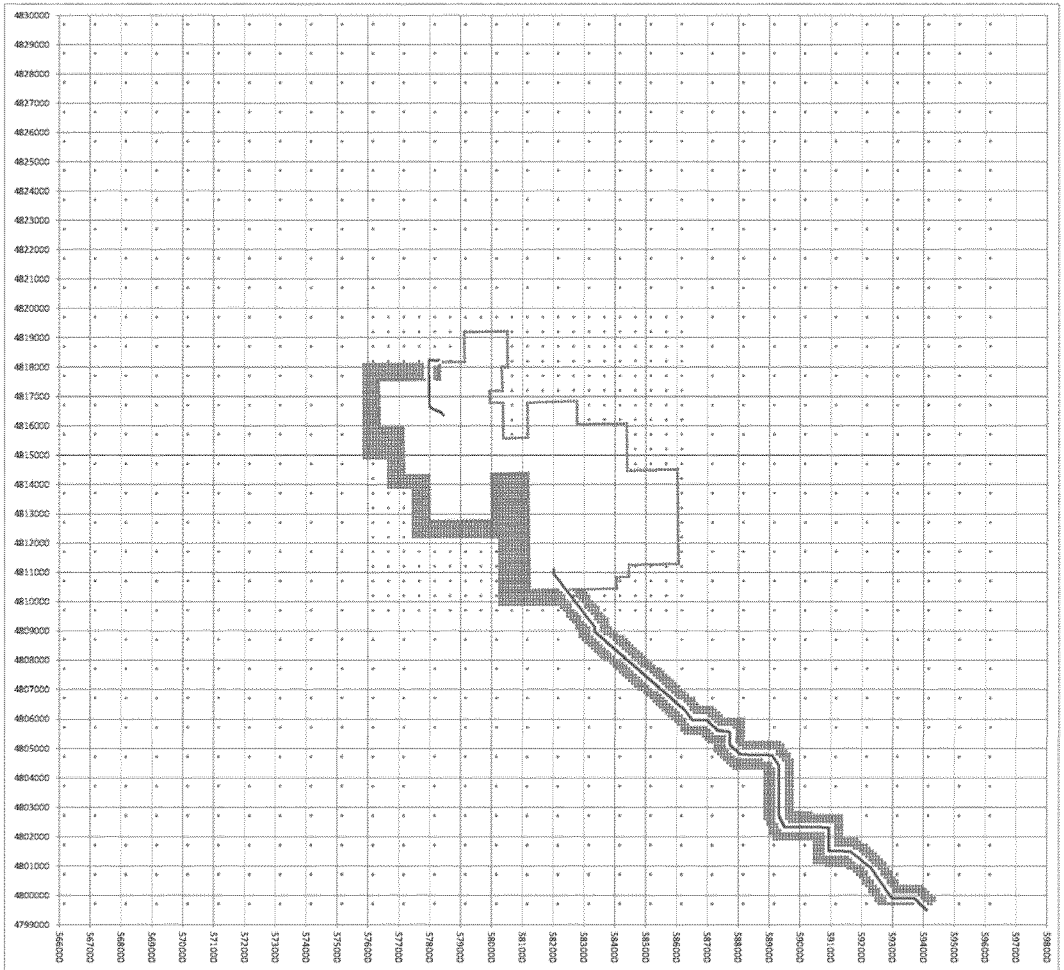
Fenceline receptors will be placed along the project boundary at least every 100 meters in linear fenceline distance, with a receptor placed at each boundary corner. To test the sensitivity of modeling results to receptor spacing, project emissions were modeled in AERMOD under two special scenarios: (a) receptors placed at 250-meter intervals around the project boundary, and (b) receptors placed at 25-meter intervals around the project boundary. Appendix C presents the results of this study, which indicates very low sensitivity to receptor spacing and supports the choice of 100 meter spacing. In addition to the project boundary receptors, 44 receptors will be placed at roughly uniform spacing around the Wind Cave National Park boundary, approximately 50 kilometers from the project site. Areas inside the project boundary will not be analyzed.

Figure 3-1: Dewey-Burdock Project AERMOD Receptors In Domain



ED_005364K_00015601-00023

Figure 3-2: Dewey-Burdock Project AERMOD Receptors Near Project and Public Road



ED_005364K_00015601-00024

3.6.2. *Hot Spot Grid*

A fine grid of receptors will be placed at 100-meter spacing within a 500-meter-wide corridor along the western and southern portions of the project boundary and along the public road accessing the project (Figure 3-2). Receptors will not be placed closer than 150 meters from the centerline of the public road. The placement of these hot spot receptors is based on preliminary modeling, which predicted that high, 24-hour PM_{10} values would be limited to this narrow corridor.

3.6.3. *Intermediate Grid*

In addition to the hot spot grid, an intermediate grid of receptors will be placed at 500-meter spacing, from the project fenceline outward to a distance 5 kilometers (km) in all directions from the project center. A second intermediate grid will be placed at 1-km spacing, from the outer edge of the first intermediate grid outward in all directions to a distance 15 km from the project center (Figure 3-2).

3.6.4. *Coarse Grid*

A coarse grid will be placed at 5-km spacing, from the outer edge of the intermediate grid outward in all directions to a distance of 35 km from the project center. A second coarse grid will also be placed at 10-km spacing, from the outer edge of the 5-km grid in all directions to a distance of 55 km from the project center (Figure 3-1).

3.7. Meteorological Data

The baseline meteorological data collected from the Dewey-Burdock site represents only one year (July 2007 to July 2008). EPA recommends that AERMOD be run with a minimum of three years of meteorological data. Therefore the model will use three years of hourly data from the meteorological station at Newcastle, Wyoming (2009 through 2011). Hourly data from a nearby station are needed for AERMOD in order to simulate wind speeds and directions synchronous with hourly emissions data. Newcastle is approximately 30 miles north-northwest of the Dewey-Burdock Project site and provides a better comparison to the Dewey-Burdock project area than the nearest National Weather Service (NWS) station (Chadron, NE) in terms of elevation, surrounding topography and proximity to the southwestern flank of the Black Hills. The station meets EPA's Meteorological Monitoring Guidance for Regulatory Modeling Applications (EPA, 2000). The Newcastle station has been accepted by NRC in conjunction with the Dewey-Burdock Project, as suitable for conducting the regional weather analysis.

No upper air data are available at the Dewey-Burdock or Newcastle sites. The upper air data will be obtained from the nearest available (and only reasonable) source, the Rapid City, South Dakota National Weather Service upper air site. This data set will be processed using the AERMET program. The surface characteristics (albedo, bowen ratio and roughness) representative of the land type surrounding the meteorological station location are required by the AERMET data processing procedures. AERSURFACE will be used to estimate the surface characteristics at the site based on land use/type files generated by the USGS. The AERMET program will combine the on-site meteorological data with the upper air data to create the AERMOD meteorological data files.

3.8. Background Concentrations

For this ambient air quality impact analysis, only the project impacts were initially modeled. Based on agency comments, background concentrations for each pollutant and averaging interval will be added to the modeled impacts to assess total ambient concentrations. The source for background concentrations is Table 3.7-3 of the Dewey-Burdock Project Draft SEIS (NRC 2012). This table was constructed from the 2008-2010 Wind Cave monitoring history. The 24-hour PM_{10} background of 85 μg/m^3 reported in the Draft SEIS is biased due to prescribed forest fires that burned very near the ambient monitor in 2009. South Dakota DENR recalculated the 2008-2010, 24-hour PM_{10} background as 41 μg/m^3 with these exceptional fire events removed. Table 3-2 lists the background concentrations used for this modeling analysis.

Note that for the AQRV impact analysis, certain background constituents will be incorporated into the model (see Section 5 below) and the modeled results will be compared to background conditions.

Table 3-2: Assumed Background Concentrations for Modeling Analysis

Pollutant	Averaging Interval and Statistic	Back-ground ($\mu g/m^3$)	NAAQS ~~Limit~~ ($\mu g/m^3$)
PM_{10}	Annual Average	--	--
	4th High 24-Hr Maximum	41.0	150
$PM_{2.5}$	Annual Average	4.8	12
	24-Hr High	10.9	35
NO_2	Annual Average	0.4	100
	98th Percentile of Daily 1-Hr Highs	5.6	187
SO_2	Annual Average	--	--
	24-Hr	--	--
	3-Hr	20.9	1300
	99th Percentile of Daily 1-Hr Highs	15.7	200
CO	8-Hr High	315.5	10000
	1-Hr High	1097.3	40000

This section is a very good description of the depletion topic.

3.9. Dry Depletion Option

Fugitive dust emissions from mobile equipment and wind erosion are the principal contributors to near-field PM_{10} impacts at Dewey-Burdock. Many studies have established the tendency for ground-level, fugitive dust emissions to partially settle out within a short distance of the emission source (EPA 1994a) (EPA 1995a). This deposition includes a portion of the PM_{10} fraction (Countess 2001). Conservation of mass requires that deposition be accompanied by plume depletion. This is the purpose of the dry depletion option in AERMOD and its predecessor model, ISC3 (EPA 1995b). Dry depletion accounts for the partial settling and deposition of PM_{10} particles as the dust plume disperses away from the source. The mechanisms for particle deposition and settling include gravity, diffusion, impaction and others. Failure to account for deposition and depletion leads dispersion models such as AERMOD to over-predict maximum 24-hour PM_{10} concentrations.

EPA guidance emphasizes the need to coordinate the use of deposition modeling options with the appropriate reviewing authority (EPA 2005). For the Dewey-Burdock Project, the AERMOD dry depletion option will not be used in the initial modeling analysis. The model execution times with dry depletion enabled are an order of magnitude longer, making it impractical to use for the entire modeling domain. The dry deposition option will, however, be considered in the refined analysis of 24-hour PM_{10} impacts. Modeling only those receptors from the initial modeling analysis that show high values, will reduce total execution time with the dry depletion option to a reasonable level. This is consistent with guidance provided by the New Mexico Air Quality Bureau (New Mexico 2006): "Because of the length of time to run a model with plume depletion, the Bureau recommends only applying plume depletion to receptors that are modeled to be above standards when the model is run without plume depletion."

3.9.1. Rationale for Using Dry Depletion in Refined PM_{10} Analysis

The Dewey-Burdock Project meets EPA's dry deposition criteria of multiple, quantifiable sources of fugitive emissions where a refined modeling analysis is being conducted and deposition is likely to occur (Trinity 2007). While these criteria were originally associated with ISC3, EPA guidance for AERMOD is similar (EPA 2005). As with most (if not all) ISR projects, fugitive dust is the dominant pollutant at Dewey-Burdock. Historically, short-term modeling of PM_{10} impacts at receptors close to fugitive dust sources has been shown to over-predict ambient concentrations (Cliffs 2011) (MMA 2011). The results of a study posted by EPA "suggest that rapid deposition of PM_{10} particles, and the relatively long residence time of the optical plume associated with small particles (<2μm), may have led to overestimates of airborne particle mass in plumes" (Fitz 2002).

The likelihood of deposition of particles in the PM_{10} size range is large for this application. In addition to gravity settling, high modeled concentrations at receptors within a few hundred meters of the fugitive emission sources suggest the likelihood of high concentration gradients. These gradients are expected to produce significant diffusion-based settling. The Fugitive Dust Model (FDM) was developed two decades ago to compute concentration and deposition impacts from fugitive dust sources. A key feature of FDM was the improved gradient-transfer deposition algorithm, which is significant for particles in the PM_{10} size class (EPA 1992).

3.9.2. Precedent for Using Dry Depletion in Refined PM_{10} Analysis

Precedent has been established by state and federal agencies for using the dry depletion option in AERMOD to model short-term impacts from fugitive dust emissions. For example, a coal lease application in Utah triggered PM_{10} modeling that included a refined analysis using deposition and plume depletion (BLM 2010). Page 9 of Appendix K in the Alton Coal Lease DEIS states, "deposition was only considered for assessing the final PM_{10} modeled ambient air impacts." Page 10 states, "the primary pollutants of concern are fugitive dust."

The Colorado Department of Public Health and Environment (CDPHE) uses dry depletion to model PM_{10} impacts from fugitive dust sources at mining facilities seeking air quality construction permits (Majano 2013). Recent projects for which this option was used include the Lafarge Gypsum Ranch Pit, Oxbow Mining's Elk Creek Mine, and Bowie Resources' Bowie N.2 Mine (currently under review). The Wyoming Department of Environmental Quality indicated that it would accept the use of plume depletion algorithms in AERMOD as long as an applicant justifies the inputs, including particle size, particle density and mass fraction (Nall 2013).

A large landfill project in eastern Oregon also modeled fugitive dust impacts using dry depletion (Westbrook 2007). The primary emission source at this facility is haul road traffic transporting waste material. The Oregon Department of Environmental Quality worked with the landfill owners to refine both the emissions inventory and the modeling protocol. The document lists plume depletion as one of the options implemented, and discusses the importance of considering PM_{10} deposition and plume depletion when modeling fugitive dust.

EPA cited dry deposition in a study conducted using ISC3 at a Wyoming surface coal mine (EPA 1995b). "In order to appropriately model the particulate emission scenarios, the depletion of dispersed particles from the plume due to gravitational settling and other dry deposition factors were considered."

A recent modeling analysis was triggered by high fugitive dust impacts in the Salt River area of Arizona. Maricopa County was reclassified as a serious PM_{10} nonattainment area on June 10, 1996. The primary sources of particulate pollution in this area are "fugitive dust from construction sites, agricultural fields, unpaved parking lots and roads, disturbed vacant lots and paved roads" (Maricopa 2006). Cited among the "general characteristics that make AERMOD suitable for application in the Salt River Study area" is the claim that "gravitational settling and dry deposition are handled well."

3.9.3. *Input Parameters for Dry Depletion Option*

AERMOD provides two methods for specifying particle characteristics under the dry depletion option. Method 1, used for this analysis, requires the user to input particle size distribution and particle density. The latter, not to be confused with bulk density, is commonly cited in the literature as 2.65 g/cm^3 for soil particles. The Environmental Science Division of Argonne National Lab states, “A typical value of 2.65 g/cm^3 has been suggested to characterize the soil particle density of a general mineral soil (Freeze and Cherry 1979). Aluminosilicate clay minerals have particle density variations in the same range” (ANL 2013). A study of fugitive dust from unpaved road surfaces also cites 2.65 g/cm^3 for soil particle density (Watson 1996).

The original PM_{10} particle size distribution was obtained from the modeling protocol for a mine in Arizona (Rosemont 2009). The modelers for the Rosemont project acquired this distribution from AP-42 Section 13.2.4 and applied it to fugitive dust emissions from haul roads. Because Section 13.2.4 applies to aggregate handling and storage piles, another source was consulted to validate the use of this particle size distribution for haul road dust. A study by Watson, Chow and Pace referenced in a New Jersey Department of Environmental Protection report (NJDEP 2005) found that 52.3% of the particulate from road and soil dust is less than 10 μm in diameter. Of this particulate 10.7% was found to be smaller than 2.5 μm in diameter and the remaining 41.6% fell between 10 and 2.5 μm. Assuming that fugitive dust particle sizes follow a lognormal distribution (EPA 2013), these two data points were transformed into a multi-point particle size distribution for comparison to the original particle size distribution. The geometric mass mean diameter for the original distribution is 6.47 μm, while the mean diameter for the lognormal distribution is 5.76 μm. Since these values are very similar, the original PM_{10} size distribution will be retained for both CALPUFF and AERMOD dry deposition modeling (Table 5-2).

4 APPLICABLE REGULATORY LIMITS FOR CITERIA POLLUTANTS

4.1. Methodology for Evaluation of Compliance with Standards

The modeled concentration of the five criteria pollutants will be compared to the National Ambient Air Quality Standards. Predicted PM_{10}, $PM_{2.5}$, SO_2, and NO_2 concentrations will also be compared to the allowable Prevention of Significant Deterioration (PSD) increments for Class I and Class II airsheds. The Dewey-Burdock Project is not subject to a regulatory PSD increment analysis since it is not a major emission source. The PSD increments and modeled concentrations are provided for disclosure purposes only.

4.2. NAAQS and PSD Increments

The applicable standards and associated averaging intervals to be used in the modeling analysis are summarized in Table 4-1. Primary standards provide public health protection. Secondary standards provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings. PSD increments protect air quality in Class I and Class II areas from significant deterioration.

Table 4-1: National Ambient Air Quality Standards (μg/m^3)

Criteria Pollutant	Averaging Time	Primary NAAQS	Secondary NAAQS	PSD Class I Increments	PSD Class II Increments
Nitrogen Dioxide	Annual	100	100	2.5	25
	1-hour	187	---	---	---
PM_{10}	24-hour	150	150	8	30
	Annual	---	---	4	17
$PM_{2.5}$	24-hour	35	35	2	9
	Annual	12	15	1	4
SO_2	1-hour	200	---	---	---
	3-hour	---	1,300	25	512
	24-hour	---	---	5	91
	Annual	---	---	2	20
CO	1-hour	40,000	---	---	---
	8-hour	10,000	---	---	---

The purpose of PSD increments is to protect public health and welfare, and to preserve, protect, and enhance the air quality in national parks, national wilderness areas, national monuments, national seashores, and other areas of special national or regional natural, recreational, scenic, or historic value. The goal of this program is to prevent significant deterioration of air quality in areas that meet the NAAQS. Areas in the U.S. have been classified in two categories for the purpose of this program. Class I areas include national wilderness areas, parks and memorial parks of a certain size, and international parks. In these areas, which include Wind Cave National Park, the allowable increase in criteria pollutant concentrations is less than in Class II areas, which includes most of the country.

4.3. Presentation of Modeling Results

The purpose of the dispersion modeling outlined in this protocol is to predict ambient air quality impacts from emissions at the Dewey-Burdock Project. These predictions will be compared to relevant NAAQS and PSD standards in the Class II area surrounding the project site and at the nearby Class I area, Wind Cave National Park. The final impact analysis will include all the information necessary for this comparison. It will include: (a) maximum impacts for each pollutant in the format of the applicable standard for each averaging period; (b) locations of the model receptors where these impacts are predicted to occur; (c) an emission source location map; (d) a complete list of source parameters; (e) complete modeling input and output files; and (f) graphic presentations of the modeling results for each pollutant, showing top receptor concentrations and isopleth maps based on predicted project impacts.

4.4. Summary

The AERMOD model with Newcastle meteorological data and maximum project emissions will be used to assess the ambient air quality impact of the criteria pollutants associated with the Dewey-Burdock Project. The model will be run with regulatory default options. A refined model run will be conducted for 24-hour PM_{10} impacts using the dry depletion option in AERMOD. Emissions of PM_{10}, $PM_{2.5}$, CO, SO_2 and NO_x associated with the proposed emission sources will be modeled. NO_x impacts will be converted to NO_2 impacts and maximum modeled concentrations of all five pollutants will be compared to NAAQS and (where applicable) PSD standards.

This sentence is incorrect The purpose is to IDENTIFY potential impacts and DISCLOSE them. Adverse impacts are allowed under NEPA. This sentence implies that any adverse impact would need to be mitigated, which is not required

5 AIR QUALITY RELATED VALUES (AQRV) MODELING METHODOLOGY

5.1. Introduction

The purpose of AQRV modeling is to ensure that Class I area resources (i.e., visibility, flora, fauna, etc.) are not adversely affected by the projected emissions from a proposed project. AQRV's are resources which may be adversely affected by a change in air quality. Based on its proximity to the Wind Cave National Park, a federally mandated Class I area, the Dewey-Burdock Project will be modeled to determine its potential AQRV impacts at Wind Cave. Species to be modeled are PM_{10}, $PM_{2.5}$, SO_2, SO_4, NO_x, $NHNO_3$ and NO_3. Elemental carbon (EC) and Organic Carbon (SOA) will also be enabled in the model, but with zero project-related emissions. This is needed for background visibility calculations and to comply with the latest Federal Land Manager protocol (FLAG 2010).

Figure 5-1 depicts the Dewey-Burdock Project boundary and the Wind Cave National Park, approximately 50 km to the east-northeast of the project. Badlands National Park lies approximately 120 km to the east of the project and is not included in this modeling exercise. Based on relative distances and prevailing wind directions, the Dewey-Burdock Project is expected to have less impact on AQRV's at Badlands National Park than at Wind Cave National Park.

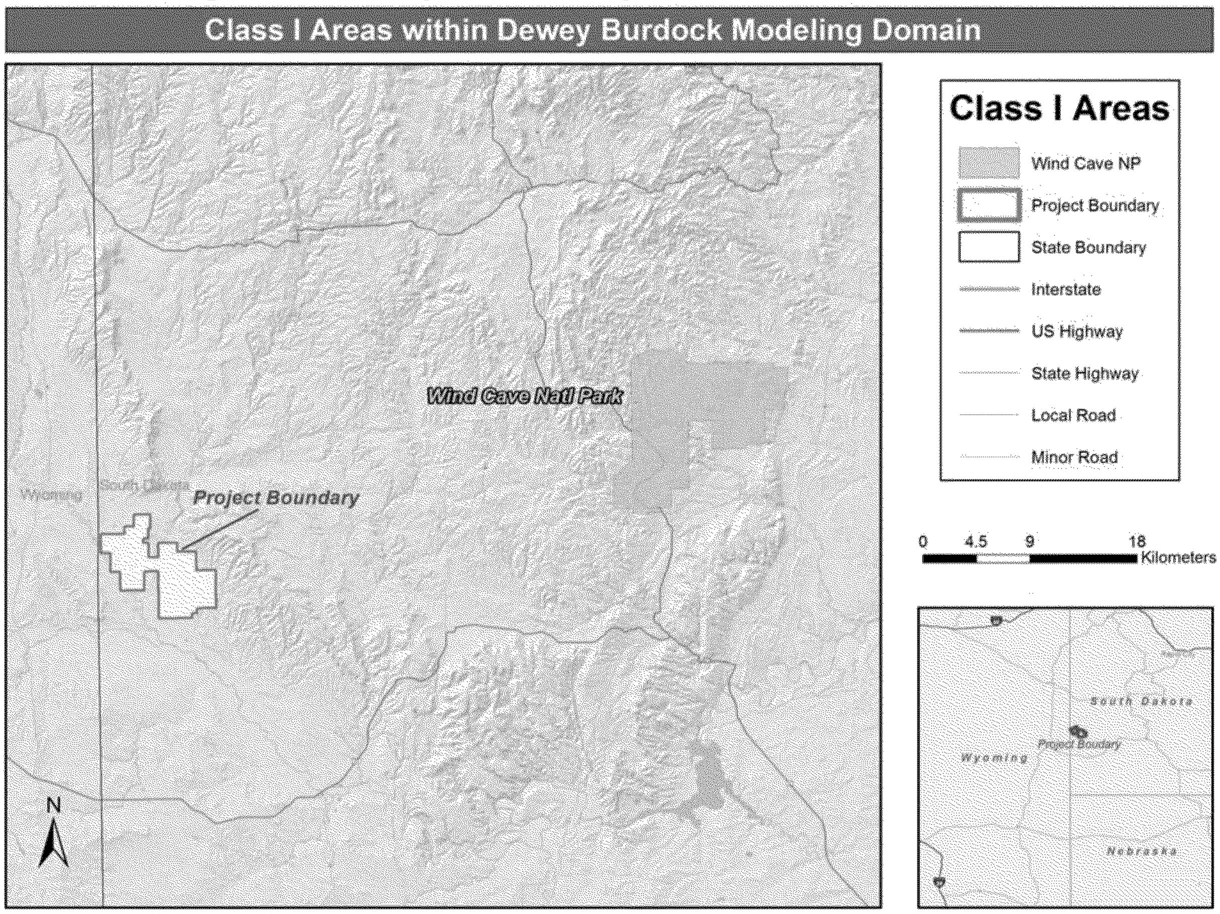
This protocol has been developed following applicable portions of the U.S. Environmental Protection Agency (EPA) guidance document: Interagency Workgroup on Air Quality Modeling (IWAQM) Phase 2 Summary Report And Recommendations for Modeling Long Range Transport Impacts, December 1998 (IWAQM 1998). It makes adjustments based on the findings of EPA's draft Reassessment of the Phase 2 Summary Report published in May 2009 (EPA 2009). It also reflects certain elements of the Western Regional Air Partnership BART protocol (WRAP 2006).

AQRVs that are generally evaluated for the federal mandatory Class I areas include:

- Visibility – Visual Plume
- Visibility – Regional Haze
- Acid Deposition

Visibility can be affected by plume impairment or regional haze. Plume impairment results from a contrast or color difference between a plume and a viewed background such as the sky or a terrain feature. Regional haze occurs at distances where the plume has become evenly dispersed in the atmosphere and is not definable. The primary causes of regional haze are sulfates and nitrates, which are formed from SO_2 and NO_X through chemical reactions in the atmosphere. Impacts at distances greater than 30 to 50 km are generally referred to as regional haze. Given that Wind Cave National Park is roughly 50 km from Dewey-Burdock and the project will not generate a singular plume of emissions, it is assumed that any visibility impacts at Wind Cave National Park will be in the form of regional haze.

Figure 5-1: Dewey-Burdock Project and Nearest Class I Area



5.2. Model Selection and Justification

Evaluation of the impacts on Air Quality Related Values (AQRVs) from the proposed Dewey-Burdock Project at Wind Cave will be conducted using CALPUFF, which is the recommended model for long range transport applications (EPA 2005). CALPUFF is also recommended by the Federal Land Managers (FLM) for AQRV analyses, to simulate visibility and deposition impacts on a Class I area (FLAG 2010). The most recent, EPA-approved verson of CALPUFF is Version 5.8. IML Air Science will us commercial version of CALPUFF 5.8 and CALMET 5.8 from Lakes Environmental, supplemented with CALPOST Version 6.4 to take advantage of recent visibility post-processing improvements. With its latest release, Lakes Environmental provides the option to combine CALPOST 6.4 (TRC Version 6.292) with CALPUFF Version 5.8 in order to conform to FLAG 2010 post-processing guidelines. The version of CALPOST is not tied to the version of CALPUFF.

no apostrophe needed

CALPUFF is a non-steady-state puff dispersion model that simulates the effects of time- and space-varying meteorological conditions on pollution transport, transformation, and removal. CALPUFF can be applied for long-range transport and for complex terrain. The CALPUFF model calculates the change in light extinction caused by a source (or group of sources) as part of the regional haze calculations. The EPA has proposed the use of CALPUFF for applications involving long-range transport, which is typically defined as transport over distances beyond 50 km (IWAQM 1998).

The CALPUFF model accounts for chemical transformations that occur during plume transport using algorithms to calculate the conversion of SO_2 to sulfates and NO_x to nitrates. The IWAQM Phase 2 report (IWAQM 1998) recommended the use of the MESOPUFF II scheme, which requires the user to select additional species to be modeled, e.g., sulfates (SO_4), nitrates (NO_3) and nitric acid (HNO_3). It also requires the input of background ozone and ammonia concentrations. Although the CALPUFF model provides default values for background concentrations, values specific to the Class I area being modeled are recommended given the sensitivity of the model to these parameters (see Section 5.5.1 below). For visibility calculations, site-specific relative humidity data are also recommended in the post processing step. Monthly average relative humidity values from Wind Cave National Park will be used for the Dewey-Burdock Project modeling.

The CALPUFF Modeling System includes three main components: CALMET, CALPUFF, CALPOST, and a large set of preprocessing and postprocessing programs designed to interface the model with standard, routinely available meteorological and geophysical datasets.

5.2.1. CALMET

CALMET is a meteorological model that develops hourly wind and temperature fields on a three-dimensional gridded modeling domain. Associated two-dimensional fields such as mixing heights, surface characteristics, and dispersion properties are also included in the file produced by CALMET.

5.2.2. CALPUFF

CALPUFF is a transport and dispersion model that advects “puffs” of material emitted from modeled sources, simulating dispersion and transformation processes along the way. In doing so it typically uses the fields generated by CALMET, or as an option, it may use simpler non-gridded meteorological fields explicitly incorporated in the resulting distribution of puffs throughout a simulation period. In this case it will use CALMET-generated meteorological data. The primary output files from CALPUFF contain either hourly concentrations or hourly deposition fluxes evaluated at selected receptor locations.

5.2.3. CALPOST

CALPOST is used to process these files, producing tabulations that summarize the results of the simulation (concentrations at each receptor, for example). When performing visibility related modeling, CALPOST uses concentrations from CALPUFF to compute extinction coefficients and related measures of visibility, reporting these for selected averaging times and locations.

5.3. Meteorological, Terrain and Land Use Data

Preprocessed data will be acquired for incorporation into CALMET. This will include three dimensional mesoscale data (MM5), hourly surface observations from weather stations in the modeling domain, upper air data from the National Weather Service (NWS) station at Rapid City, precipitation data, terrain elevations, and land use classifications.

5.3.1. Time Period

According to 40 CFR Part 51 Appendix W, the length of the modeled meteorological period should be long enough to ensure that the worst-case meteorological conditions are adequately represented in the model results. EPA recommends that consecutive years from the most recent, readily available 5-year period are preferred, but when mesoscale meteorological data are used (i.e., MM5) three years of modeling is acceptable (WRAP BART Modeling Protocol).These mesoscale meteorological fields should be used in conjunction with available standard NWS or comparable meteorological observations within and near the modeling domain. Therefore this modeling analysis will be conducted using 3 years (2009, 2010, 2011) of mesoscale meteorological model output data coupled with observational data from nearby surface, upper air and precipitation stations.

5.3.2. Prognostic Meteorological Data

The CALMET/CALPUFF modeling system currently includes the capability to incorporate 3-dimensional prognostic meteorological data from a mesoscale wind field model (MM5) into the processing of meteorological data through the CALMET Diagnostic Wind Model (DWM). This is most commonly accomplished by using the MM5 data as the initial guess for the wind field in CALMET. The MM5 data used in this modeling effort will span a 200 km by 200 km modeling domain centered at the Dewey-Burdock Project site, with 12-km horizontal resolution and 18 vertical layers. This data set will be obtained from Lakes Environmental.

5.3.3. CALMET Diagnostic Meteorological Data

EPA recommends using a "hybrid" CALMET, to include MM5 and weather station data (EPA 2009). EPA recommends against the use of the "no-observation" methods for CALMET (NOOBS=1, 2). The CALMET NOOBS mode is less conservative, therefore meteorological observations will be blended with the MM5 data as input to the CALMET/CALPUFF modeling system. These will include three years of hourly meteorological data from the Dewey-Burdock on-site station, the Newcastle station, and the NWS station at Chadron, NE. Three years of upper air data will be obtained from Rapid City, the only upper air station in the region. Precipitation data will be supplied by a collection of 18 weather stations in the modeling domain. Traditionally, the FLMs have recommended a CALMET grid resolution of approximately 4 km. There is concern that the increased structural detail in the horizontal wind fields resulting from application of CALMET at higher grid resolutions may lead to spurious effects on plume dispersion which may not be obvious (WRAP 2006). EPA studies show little, if any, sensitivity to the increase in grid resolution within CALMET relative to the MM5 grid resolution (EPA 2009). Therefore, a 4 km grid resolution will be used for CALMET.

5.3.4. CALMET Approach

CALMET uses a two-step approach to calculate wind fields. In the first step, an initial guess field is adjusted for slope flows and terrain blocking effects, for example, to produce a step 1 wind field. In the second step, an objective analysis is performed to introduce observational data into the Step 1 wind field. EPA recommends elimination of CALMET diagnostic adjustments to first-guess wind field (EPA 2009). EPA recommends continuation of incorporation of surface observations for radii of influence (RMAX1, RMAX2, RMAX3, R1, R2, R3) set to minimal values to preserve the integrity of prognostic meteorological data used as the first-guess wind field. These recommendations will be followed in modeling the Dewey-Burdock Project.

5.3.5. CALMET Parameter Settings

The maximum mixing height (ZIMAX) has an EPA default value of 3000 m AGL. All the other parameters are set on a case by case basis taking the terrain surrounding the observation stations into consideration.

5.3.6. Terrain Data

Gridded terrain elevations for the modeling domain are derived from 3 arc-second digital elevation models (DEMs) produced by the United States Geological Survey (USGS). The files cover 1-degree by 1-degree blocks of latitude and longitude. The elevations are in meters relative to mean sea level and have a resolution of about 90 meters. These data will be processed to generate 4 km average terrain heights that will be input into CALMET.

5.3.7. Land Use Data

Surface properties such as albedo, Bowen ratio, roughness length and leaf area index are computed proportionally to the fractional land use. The land use data is based on the Composite Theme Grid format (CTG) using Level I USGS land use categories. The 4 km land use grid will be mapped into the 14 primary CALMET land use categories.

5.3.8. CALMET Switch Settings

Most of the default switch settings for CALMET will be used. Table 5-1 lists some of the key parameter settings as proposed, and as implemented in the WRAP Protocol (WRAP 2006).

Table 5-1: CALMET Switch Settings

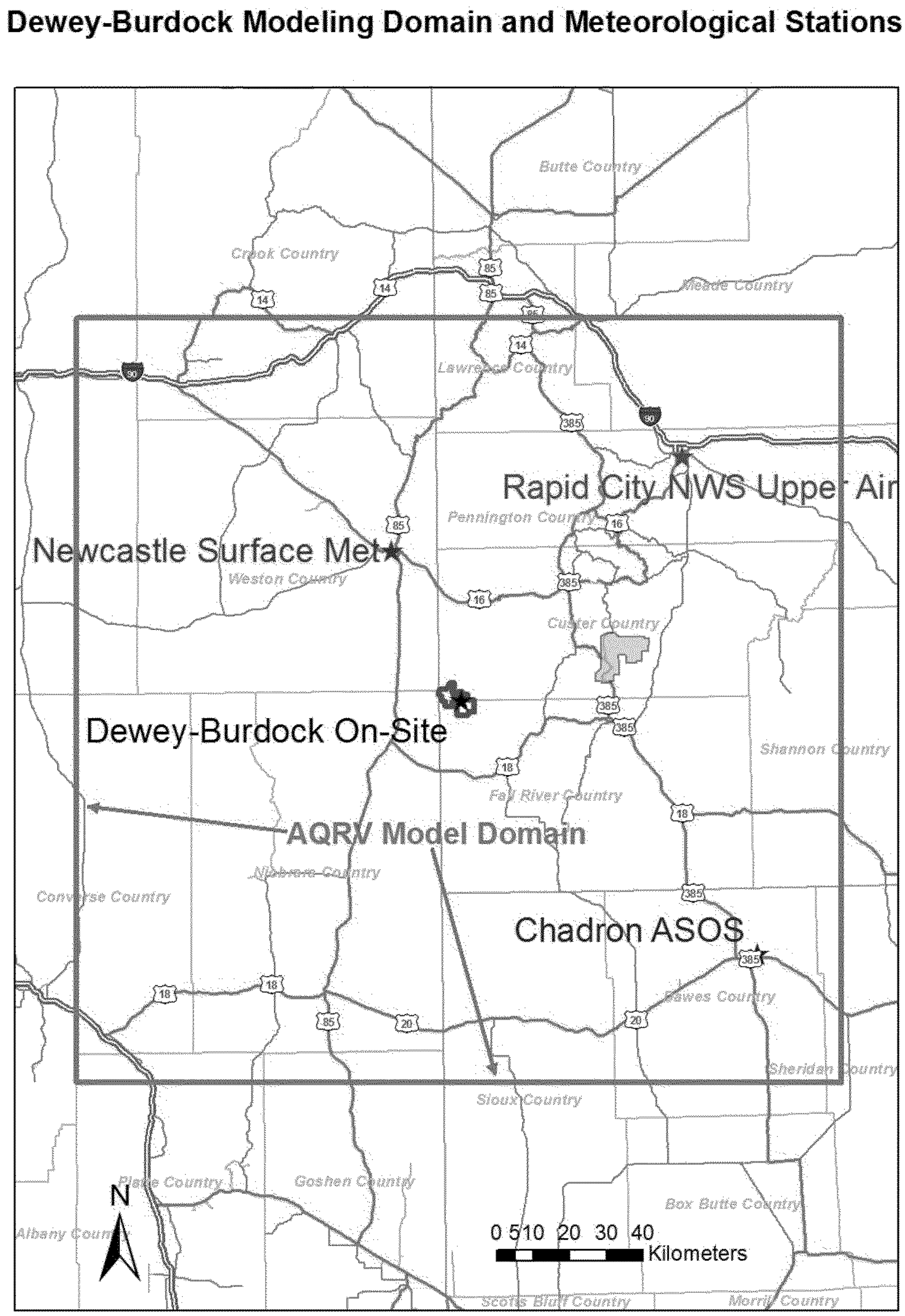
Parameter	WRAP Setting	Proposed Setting
R1MAX	50 KM	60 KM
R2MAX	100 KM	100 KM
R3MAX	100 KM	100 KM
R1	100 KM	30 KM
R2	200 KM	50 KM
ZIMAX	4500 m AGL	3000 m AGL
TERRAD	10 KM	16 KM

5.4. Modeling Domain and Receptors

Figure 5-2 shows the proposed AQRV modeling domain. In order to adequately characterize potential AQRV impacts to Wind Cave National Park, the modeling domain will extend 100 km in all directions from the Dewey-Burdock Project (200 km by 200 km grid). IWAQM recommends modeling 50 km beyond the relevant Class I boundary to provide a buffer and to account for any potential wind circulation. For Dewey-Burdock, the proposed buffer width meets this criterion.

Receptor locations and elevations for the Wind Cave National Park Class I area will be obtained from the National Park Service database in order to generate visibility data compatible with and comparable to previous modeling exercises.

Figure 5-2: Dewey-Burdock Project CALPUFF Modeling Domain and Surface Meteorological Stations



5.5. CALPUFF Model Inputs

5.5.1. Background Concentrations

CALPUFF requires ozone and ammonia background concentrations in order to characterize atmospheric chemistry. These species influence the rates of formation of sulfates and nitrates, aerosols that affect visibility.

Although a uniform background value for ozone may be adequate for small modeling domains, this modeling exercise will incorporate a time varying background. Accordingly, monthly ozone concentrations will be calculated using data from the Clean Air Status and Trends Network, or CASTNet.

For ammonia background, IWAQM recommends 1 ppb for forested lands, 10 ppb for grasslands, and 0.5 ppb for arid lands (IWAQM 1998). The relevant ammonia background is at Wind Cave National Park, not the entire modeling domain. Since the predominant land use at Wind Cave is forest, a conservative value of 1 ppb will be used in the model.

5.5.2. Chemistry Modeling

The MESOPUFF II pseudo-first-order chemical reaction mechanism (MCHEM=1) will be used for the conversion of SO_2 to sulfate (SO_4) and NO_x to nitrate (NO_3) as recommended by EPA (WRAP 2006). MESOPUFF II is a 5-species scheme in which all emissions of nitrogen oxides are simply input as NO_x. In the MESOPUFF II scheme, the conversion of SO_2 to sulfates and NO_x to nitrates is dependent on relative humidity (RH), with an enhanced conversion rate at high RH. This modeling exercise will therefore incorporate an adjustment factor for RH. Aqueous phase oxidation is currently not modeled, leading to an underestimation of sulfate formation in clouds or fog.

5.5.3. Particle Size Distribution

The dominant pollutant emitted from the Dewey-Burdock Project will be fugitive PM_{10}. Calpuff models the atmospheric dispersion and attempts to model the settling of particulate matter based on an input particle size distribution. This modeling exercise will use a PM_{10} size distribution for haul road dust taken from the Rosemont Copper Project protocol (Rosemont 2009) and based on AP-42 Section 13.2.4 (EPA 1995c). Table 5-2 lists the corresponding size distribution.

Table 5-2: Fugitive PM_{10} Particle Size Distribution

Particle Size (µm)	Fraction
2.2	0.069
3.17	0.128
6.1	0.385
7.82	0.224
9.32	0.194

All tailpipe particulate emissions will be modeled as $PM_{2.5}$.

5.5.4. CALPUFF Switch Settings

Most of the default switch settings for CALPUFF will be used. Table 5-3 lists the default values and proposed values for some of the key parameter settings. The increase in number of species emitted accounts for NO_x, SO_2, PM_{10} and $PM_{2.5}$ emissions.

Table 5-3: CALPUFF Switch Settings

Parameter	Description	Default Value	Proposed Value	Notes
Group 1 – General Options				
NSPEC	Number of chemical species	5	9	
NSE	Number of species emitted	3	4	
METFM	Meteorological data format	1	1	1 = CALMET file
PGTIME	Pasquill-Gifford (PG)	60	60	Minutes
MGAUSS	Near-field vertical distribution	1	1	1 = Gaussian
MCTADJ	Terrain adjustments to plume path	3	3	3 = Partial plume path adjustment
MCHEM	Chemical mechanism	1	1	1 = MESOPUFF II chemistry
MDISP	Method for dispersion coefficients	3	3	3 = PG for rural and McElroy-Pooler (MP) for urban
MREG	Regulatory default checks	1	1	1 = Technical options must conform to EPA Long Range Transport guidance
SYTDEP	Equations used to determine sigma-y and -z	550	550	Puff size (m) beyond which equations (Heffter) are used to determine sigma y and z
MHFTSZ	Heffter equation for sigma z	0	0	0 = Not use Heffter

5.6. CALPUFF Model Outputs, Calculations and Evaluation Methods

5.6.1. CALPOST and POSTUTIL

The CALPUFF results will be post-processed using the CALPOST and POSTUTIL processors. POSTUTIL is a post processing program used to process the concentrations generated by CALPUFF. POSTUTIL occurs prior to the visibility processing in CALPOST and allows the user to sum the contributions of sources from different CALPUFF simulations into a total concentration file. Monthly RH adjustment factors will be applied directly to the background and modeled sulfate and nitrate concentrations in CALPOST.

5.6.2. Visibility Impact Determination

The general theory for performing visibility calculations with the CALPUFF modeling system is described in the Interagency Workgroup on Air Quality Modeling Phase 2 Summary Report and Recommendations for Modeling Long Range Transport Impacts (IWAQM 1998). The theory is also summarized in Section 5.6.4 below. Change of light extinction is the preferred metric for assessing visibility impairment. Visibility impact on a Class I area is considered significant if the source's contribution to visibility impairment, modeled as the 98th percentile of the daily (24-hour) changes in deciviews (dv), is equal to or greater than the contribution threshold of 0.5 dv (FLAG 2010). Stated differently, a source can be reasonably anticipated to cause or contribute to an impairment of visibility if the 98th percentile of the distribution of modeled changes in light extinction is greater than 0.5 dv. Changes in visibility at Wind Cave National Park will be calculated from the Dewey-Burdock Project model outputs and reported in terms of the 98th percentile change in dv at each modeled receptor, as well as the total light extinction at each receptor.

5.6.3. Comparison to Existing AQRV Status

Assessing some Air Quality Related Values (e.g., crop injury, or visibility effects) is fundamentally tied to knowing the current stress being exerted on the system. This is reflected in the current background visibility. Assessing the response of a resource is related to the cumulative effects of all the current existing stresses (IWAQM 1998). The evaluation of the Dewey-Burdock modeling results will therefore consider the current visual resource and visibility impairment at Wind Cave National Park. Studies conducted by the National Park Service and the Western Regional Air Partnership (WRAP) will provide references for current conditions.

5.6.4. Calculation of Light Extinctions

The calculation of regional visibility impacts in CALPUFF takes into account the scattering of light caused by several particulate matter (PM) constituents in the atmosphere. This scattering of light is referred to as extinction. The PM constituents that are accounted for in the visibility calculations include ammonium sulfate, ammonium nitrate, organic carbon, elemental carbon, soil, and coarse and fine PM. The CALPUFF model calculates the light extinction attributable to a source's emissions and compares it to the extinction caused by the background constituents to estimate a change in extinction.

The extinction caused by a source's emissions is affected by several factors. One such factor is the formation of light scattering constituents by chemical transformation during plume transport, e.g., conversion of SO_2 to sulfates and NO_x to nitrates. These chemical transformations are dependent on the level of available gaseous ammonia and ozone in the atmosphere, i.e., the higher the ammonia and ozone concentration in the air, the greater the transformation, and hence the greater the light extinction. Since sulfates and nitrates are hygroscopic in nature, the light extinction caused by these constituents is also affected by relative humidity (RH). The other PM constituents are considered to be non-hygroscopic. The visibility analysis will be conducted using monthly average relative humidity adjustment factors, or f(RH) values.

The CALPOST postprocessor will be used for the calculation of the impact from the modeled source's primary and secondary particulate matter concentrations on light extinction. The formula that is used is the existing IMPROVE/EPA formula, which is applied to determine a change in light extinction due to increases in the particulate matter component concentrations. Using the notation of CALPOST, the formula is the following:

B_{ext} = 2.2 x fS(RH) x [Small Sulfates] + 4.8 x fL(RH) x [Large Sulfate]
+ 2.4 x fS(RH) x [Small Nitrates] + 5.1 x fL(RH) x [Large Nitrates]
+ 2.8 x [Small Organic Mass] + 6.1 x [Large Organic Mass]
+ 10 x [Elemental Carbon]
+ 1 x [Fine Soil]
+ 0.6 x [Coarse Mass]
+ 1.7 x fSS(RH) x [Sea Salt]
+ [Rayleigh Scattering]
+ 0.33 x [NO2 (ppb)]

The concentrations, in square brackets, are in $\mu g/m^3$ and b_{ext} is in units of inverse megameters or Mm-1. The Rayleigh scattering term will be set to the value of 10 Mm-1, the default value recommended in EPA guidance for tracking reasonable progress (WRAP 2006).

Each hour's source-caused extinction is calculated by first using the hygroscopic components of the source caused concentrations, due to ammonium sulfate and nitrate, and monthly f(RH) values specific to Wind Cave National Park. The contribution to the total source-caused extinction from ammonium sulfate and nitrate is then added to the other, non-hygroscopic components of the particulate concentration to yield the total hourly source caused extinction. The terms fS(RH), fL(RH) and fSS(RH) are relative humidity adjustment factors for small particles, large particles and sea salts respectively. These values will be taken from the Federal Land Managers Air Quality Related Values Workgroup Phase 1 Report Revised Draft Table V.1-2, V.1-3 and V1.-4 (FLAG 2008) which list f(RH) values for each Class I area.

5.6.5. Deposition Analysis

Atmospheric deposition includes wet and dry fluxes of the pollutants modeled (g/m^2/sec), represented as sulfur and nitrogen calculated in pollutant-specific runs of CALPOST. Modeled fluxes are for the modeled species and do not directly represent the mass flux of either sulfur or nitrogen. Adjustments are therefore made for the ratio of molecular weight of S and N vs. the molecular weight of the species modeled (SO_2, SO_4, NO_x, HNO_3, NO_3). The deposition flux of sulfur includes contributions from any modeled sulfur compounds. The deposition flux of nitrogen includes contributions from any modeled nitrogen compounds.

The CALPUFF output files will contain the wet and dry deposition fluxes of both primary and secondary species. The wet and dry fluxes must be added to obtain the total flux of each species, at each receptor, each hour. The POSTUTIL processor will be configured to sum the wet and dry fluxes, and to compute the total sulfur and nitrogen contributed by the modeled species for subsequent CALPOST processing.

5.6.6. CALPOST Switch Settings

Table 5-4 lists default and proposed values for key parameters for CALPOST. The maximum relative humidity will be lowered from 98% to 95% based on recent FLM guidance (FLAG 2008). The default value for LVPMC is "True," indicating that coarse particulate matter ($PM_{10-2.5}$) is included in the visibility model. CALPOST will also be run with LVPMC set to "False." Both sets of results will be presented. The differences between these two modes and the rationale for evaluating both are discussed in conjunction with the visibility modeling results in Section 7.2.3.

5.7. Presentation of Modeling Results

The purpose of the AQRV modeling outlined in this protocol is to disclose impacts from emissions at the Dewey-Burdock Project to Air Quality Related Values (AQRV) at the nearby Class I area, Wind Cave National Park. The final impact analysis will present all predicted impacts from the project, and compare these predictions to background conditions. The visibility impact analysis will include the 98th percentile of the 24-hour changes in haze index (deciviews), and an isopleth map of the total light extinction (background plus project-induced) at Wind Cave. It will also include an isopleth map showing maximum nitrogen and sulfur deposition at Wind Cave, with a table comparing modeled deposition rates to monitored conditions, significance thresholds and critical loads.

Table 5-4: CALPOST Switch Settings

Parameter	Description	Default Value	Proposed Value	Notes
Group 1				
ASPEC	Species to process	No Default	VISIB	Visibility processing
Group 2				
MFRH	Particle growth curve f(RH)	4	4	4 = IMPROVE (2006) f(RH) tabulations for sea salt and for sulfate and nitrate
RHMAX	Maximum relative humidity (%) in growth curve	98	95	FLAG (2008) guidance
Modeled Species				
LVSO4	Include sulfate	T	T	
LVNO3	Include nitrate	T	T	
LVNO2	Include nitrogen dioxide absorption	T	T	
LVOC	Include organic carbon	T	T	
LVPMC	Include coarse particulates	T	T	
LVPMF	Include fine particulates	T	T	
LVEC	Include elemental carbon	T	T	
Extinction Efficiency				
EEPMC	Particulate matter coarse	0.6	0.6	
EEPMF	Particulate matter fine	1.0	1.0	
EEPMCBK	Particulate matter coarse background	0.6	0.6	Background particulate species
EESO4	Ammonium sulfate	3.0	3.0	
EENO3	Ammonium nitrate	3.0	3.0	
EEOC	Organic carbon	4.0	4.0	
EESOIL	Soil	1.0	1.0	
EEEC	Elemental carbon	10.0	10.0	

6 AERMOD MODELING RESULTS AND ANALYSIS

6.1. Introduction

The stationary and fugitive emission sources at the Dewey-Burdock Project will produce particulate matter smaller than ten microns in size (PM_{10}) and particulate matter smaller than 2.5 microns in size ($PM_{2.5}$). Stationary and mobile sources will emit PM_{10}, $PM_{2.5}$, carbon monoxide (CO), sulfur dioxide (SO_2) and oxides of nitrogen (NO_x). It was assumed that 75% of NO_x emissions will be converted to NO_2. Thus, five criteria pollutants (PM_{10}, $PM_{2.5}$, CO, SO_2 and NO_2) were analyzed for compliance with the NAAQS using the AERMOD dispersion modeling software. For disclosure purposes four of these pollutants, PM_{10}, $PM_{2.5}$, SO_2 and NO_2 were further analyzed for comparison to the allowable PSD increments in Class I and Class II areas. For each scenario, emissions from all 34 on-site and off-site emission sources identified and quantified in the Dewey-Burdock Project emissions inventory (Figures 6-2 and 6-3), were modeled. Each model run, with the exception of a "dry depletion" run discussed in Section 6.2 below, produced maximum pollutant concentrations and related statistics at all 4,220 receptors in the 110-km by 110-km modeling domain (Figure 6-1).

Table 6-1 summarizes the results of the AERMOD model runs for all pollutants and relevant averaging intervals. The results are presented in the format of the applicable NAAQS, referred to as design values. Predicted total ambient concentrations are computed as the sum of the design-value project impacts and the background concentrations. Sections 6.2 through 6.6 discuss these results in detail for each of the five criteria pollutants. With the exception of the initial 24-hour PM_{10} modeling results, all receptors were predicted to be in compliance with all NAAQS as reflected in Table 6-1. The refined 24-hour PM_{10} modeling analysis, with the dry depletion option enabled in AERMOD, predicted compliance with the NAAQS at all receptors.

Table 6-2 compares model predictions with PSD Class I and Class II increments. Although the Dewey-Burdock Project is not a major source and therefore does not meet the criteria for PSD regulation, these results are presented for disclosure purposes. It can be seen from Table 6-2 that all Class I impacts fall below the associated PSD increment. All Class II impacts are also below the PSD increment, except for the 24-hour PM_{10} values. Receptors with predicted values above the increment were confined to a narrow corridor along the public road and the northwestern portion of the project boundary (see Section 6.2).

Section 6.2 discusses the initial PM_{10} modeling results, which showed 3 receptors with 4th high 24-hour (design value) concentrations in excess of the 24-hr NAAQS. With background added to modeled concentrations, 50 receptors exceeded the NAAQS in the initial model run. Section 6.2 also presents a refined modeling analysis for these 50 top receptors only, using the dry depletion option to account for particle deposition and plume depletion. The refined analysis predicted that all receptors would be in compliance with the PM_{10} 24-hr NAAQS.

Sections 6.3 through 6.6 discuss modeling results for $PM_{2.5}$, NO_2, SO_2 and CO. For these pollutants the model results predicted compliance with all applicable NAAQS and PSD increments.

Table 6-1: Summary of Predicted Pollutant Concentrations (AERMOD)

Pollutant	Averaging Interval and Statistic	Ambient Impact (µg/m³)	Back-ground (µg/m³)	Total Ambient Concentration (µg/m³)	NAAQS Limit (µg/m³)	Receptor (UTM Easting, Northing)	1st Year Statistic (1st High for 24-Hr PM_{10})	2nd Year Statistic (2nd High for 24-Hr PM_{10})	3rd Year Statistic (3rd High for 24-Hr PM_{10})
PM_{10} Initial Run (No Dry Depletion)	Annual Average	8.8	--	--	--	582358, 4810210	--	--	--
	4th High 24-Hr Maximum	187.2	41.0	228.2	150	590758, 4801610	263.1	217.9	194.4
PM_{10} Final Run (Top 50 Receptors With Dry Depletion)	Annual Average	5.8	--	--	--	590758, 4802110	5.5	6.1	6.0
	4th High 24-Hr Maximum	83.6	41.0	124.6	150	589258, 4802410	116.1	94.9	84.2
$PM_{2.5}$	Annual Average	1.0	4.8	5.8	12	577137, 4815932	--	--	--
	24-Hr High	6.9	10.9	17.8	35	577137, 4815932	7.9	7.5	5.3
NO_2	Annual Average	1.1	0.4	1.5	100	576358, 4816510	--	--	--
	98th Percentile of Daily 1-Hr Highs	156.9	5.6	162.5	187	577137, 4815932	191.6	159.8	119.2
SO_2	Annual Average	0.2	--	--	--	577137, 4815932	--	--	--
	24-Hr	12.6	--	--	--	576358, 4816510	--	--	--
	3-Hr	100.1	20.9	121.0	1300	576358, 4816510	--	--	--
	99th Percentile of Daily 1-Hr Highs	48.3	15.7	63.9	200	577137, 4815932	58.5	50.1	36.2
CO	8-Hr High	262.6	315.5	578.1	10000	576358, 4816510	--	--	--
	1-Hr High	2101.1	1097.3	3198.4	40000	576358, 4816510	--	--	--

Table 6-2: Summary of PSD Increment Comparisons (AERMOD)

Pollutant	Averaging Interval and Statistic	Class I Impact	Allowable Class I PSD Increment	Class II Impact	Allowable Class II PSD Increment
PM_{10} Initial Run (No Dry Depletion)	Annual Average	0.05	4	8.8	17
	4th High 24-Hr Maximum	1.95	8	187.2	30
PM_{10} Final Run (Top 50 Receptors With Dry Depletion)	Annual Average	--	4	5.8	17
	4th High 24-Hr Maximum	--	8	83.6	30
$PM_{2.5}$	Annual Average	0.01	1	1.0	4
	24-Hr High	0.05	2	6.9	9
NO_2	Annual Average	0.01	2.5	1.1	25
	98^{th} Percentile of Daily 1-Hr Highs	1.16	--	156.9	--
SO_2	Annual Average	0.00	2	0.2	20
	24-Hr	0.25	5	12.6	91
	3-Hr	1.64	25	100.1	512
	99^{th} Percentile of Daily 1-Hr Highs	0.51	--	48.3	--
CO	8-Hr High	4.12	--	262.6	--
	1-Hr High	19.48	--	2101.1	--

Figure 6-1: AERMOD Modeling Domain and Receptors

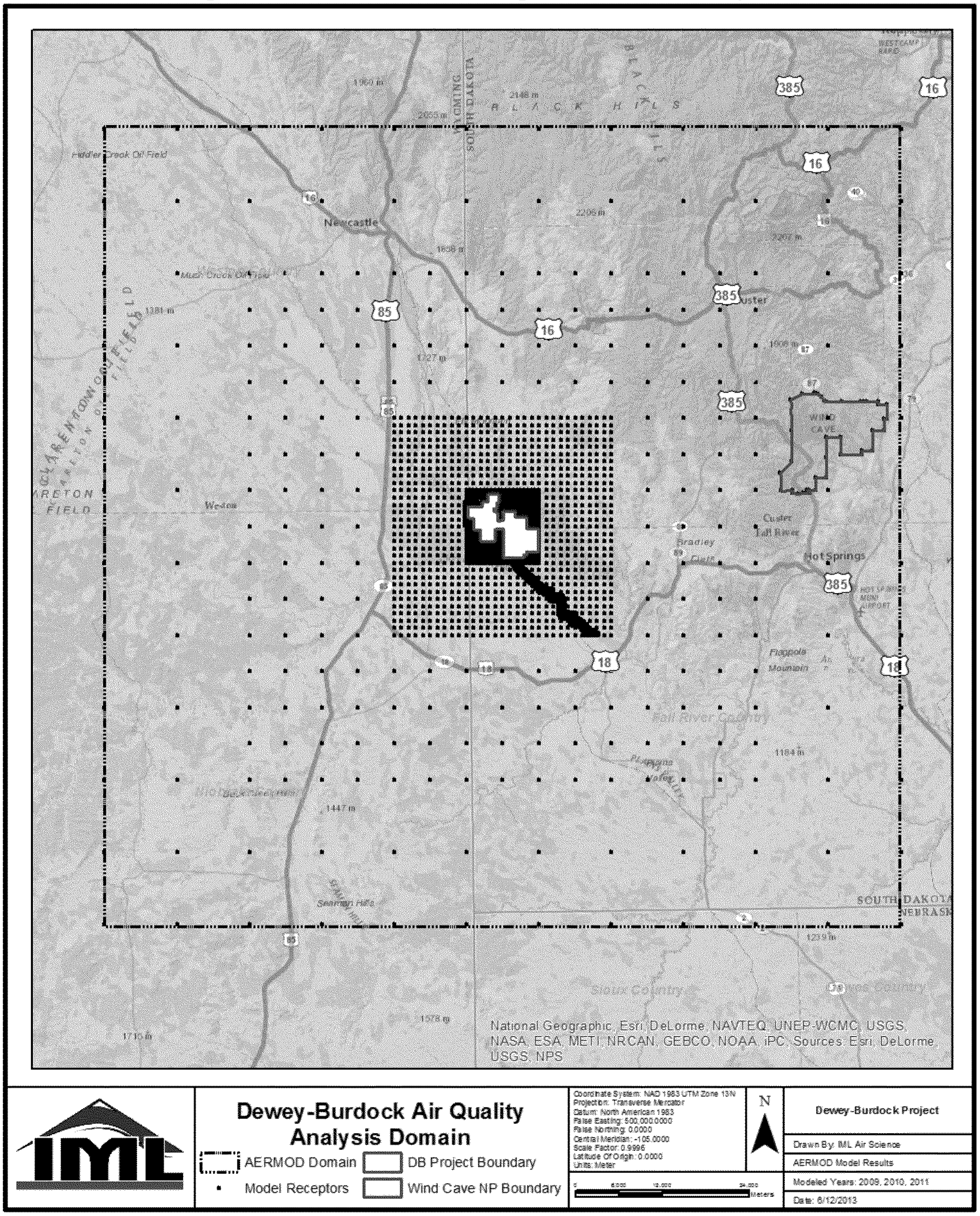


Figure 6-2: Dewey-Burdock Project Modeled Emission Sources

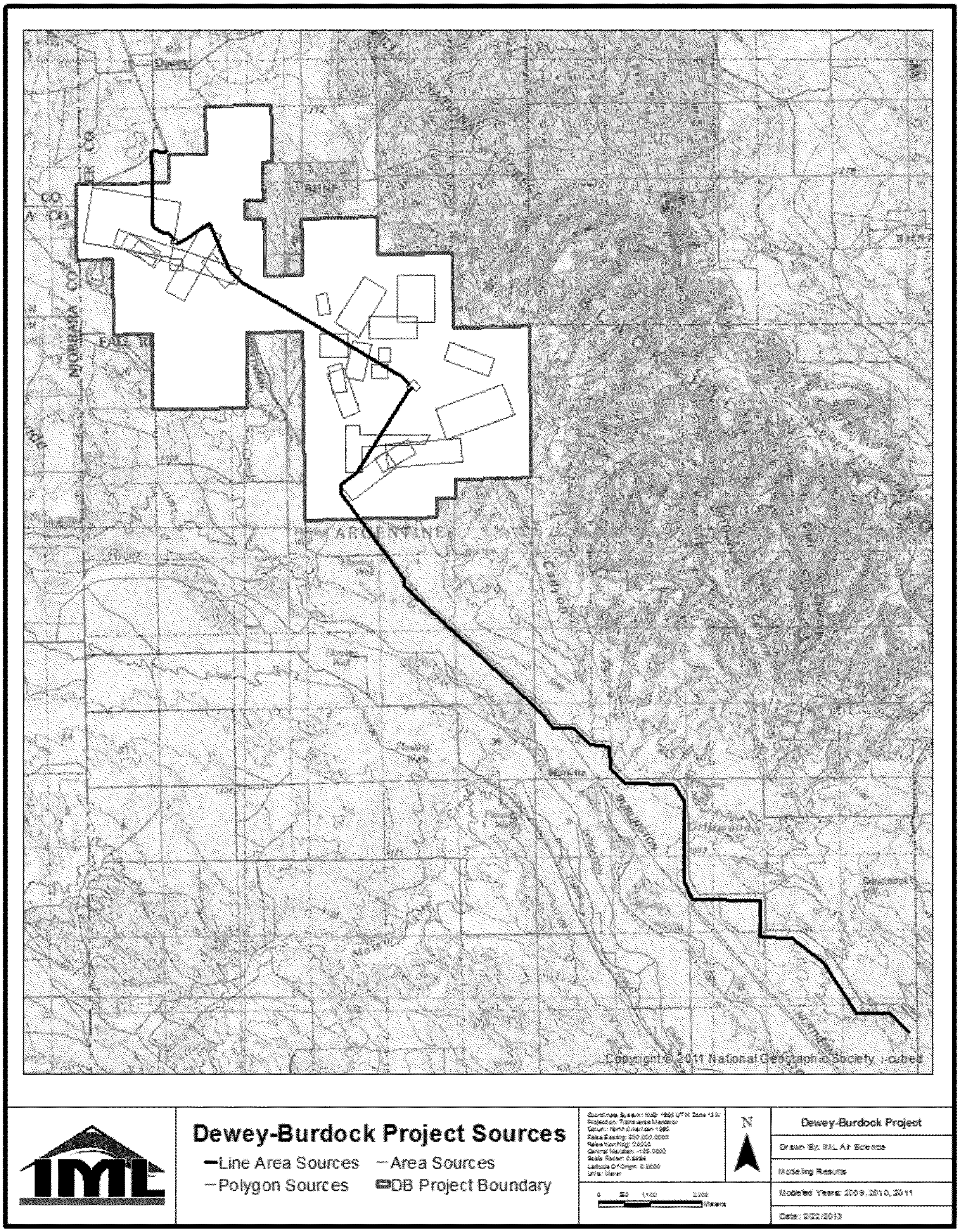
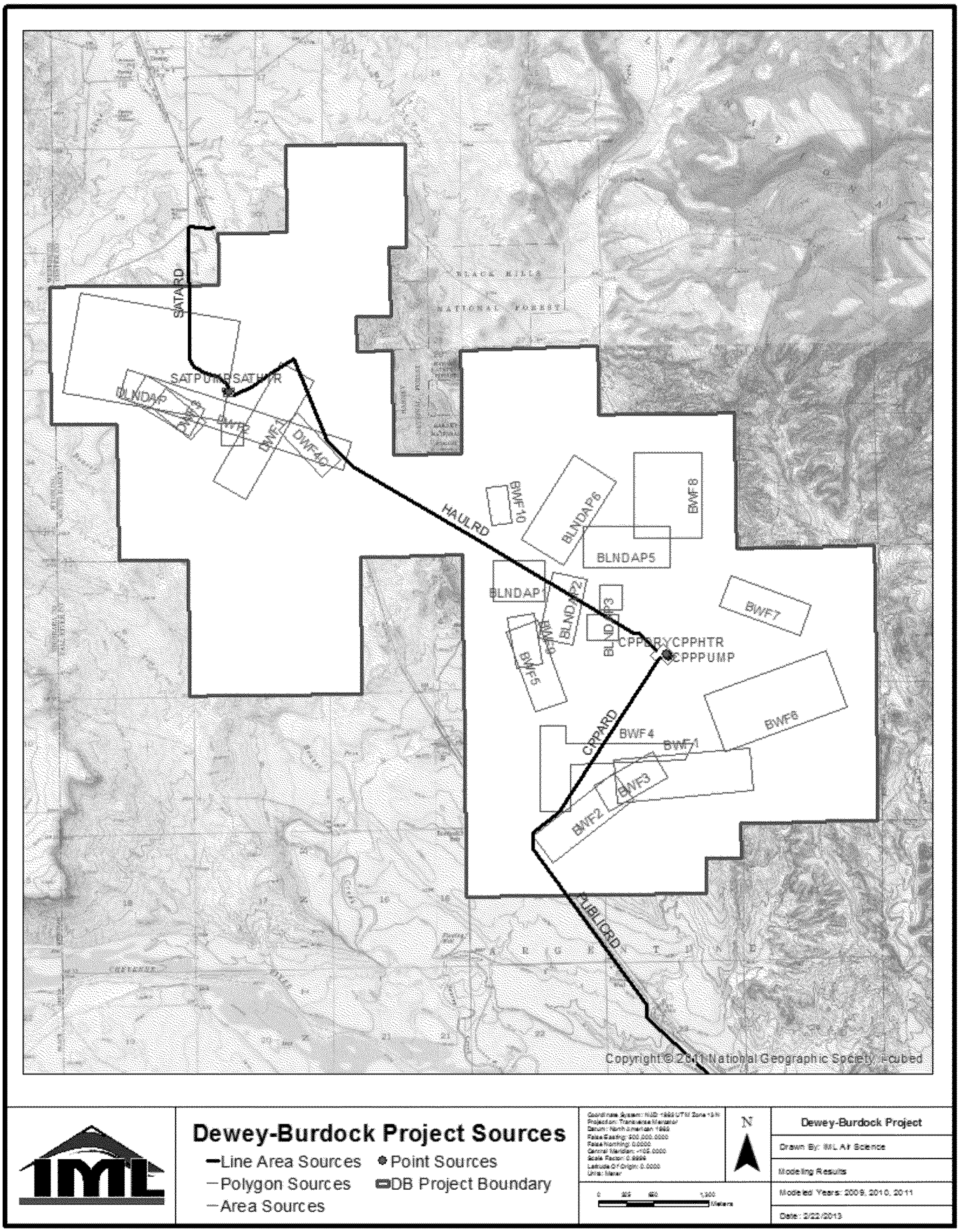


Figure 6-3: Dewey-Burdock Project Modeled Emission Source Detail



6.2. PM_{10} Modeling Analysis

Particulate matter in the form of PM_{10} emissions will constitute the single largest air pollutant from the proposed Dewey-Burdock Project. The primary source of PM_{10} emissions will be fugitive dust generated by traffic on unpaved roads, road maintenance, drilling and construction activities, and wind erosion on disturbed areas. A small fraction of the total PM_{10} emissions will be generated by internal engine fuel combustion. Nearly all of these combustion emissions will also qualify as $PM_{2.5}$ (particles with aerodynamic diameter less than 2.5 microns). Accordingly, the outcome of this PM_{10} modeling study is driven by ground-level sources of fugitive dust.

The maximum yearly PM_{10} emissions from the Dewey-Burdock Project were modeled for potential impacts on ambient air quality at all receptors in the modeling domain. Both on-site and off-site, project-related emission sources were included in the model. Variable emission rates were used, based on month, day and hour. The model produced maximum receptor concentrations for any calendar day (24-hr average) and for the entire modeling period (annual average). In order to characterize worst-case, short-term impacts, the modeling period spanned three years of hourly meteorological conditions.

6.2.1. Initial PM_{10} Modeling Results

Results from the initial AERMOD run are presented below. Table 6-3 lists the top 20 receptors ranked by annual average concentrations. Table 6-4 lists the top 50 receptors ranked by 4^{th} high, 24-hour concentrations (consistent with the NAAQS format). Figure 6-4 is an isopleth, or contour plot of the annual ~~impacts~~ from the Dewey-Burdock Project. Figure 6-5 is an isopleth map of the maximum 24-hr ~~impacts~~ from the Dewey-Burdock Project.

For both figures, clarify if the concentrations are modeled or total concentrations.

Table 6-3 shows all receptors were well below the previous annual NAAQ (standard no longer exists). None of the 4,220 receptors had modeled co above the annual, Class II PSD increment of of 17 μg/m^3. None of the Wind Cave receptors were above the annual Class I PSD increment (Table 6-2). ~~Table 6-4 shows 3 receptors exceeding the 24-hr NAAQS of 150 μg/m^3.~~ With a background of 41 μg/m^3 added to modeled impacts, the initial PM_{10} model run predicted 50 receptors above the NAAQS during the 3-year modeling period. Figure 6-6 illustrates the proximity of the top

This sentence should be deleted because this is not a direct comparison. Comparisons to NAAQS must be based on total predicted concentration.

10 receptors to the fugitive PM_{10} emission sources. All of the modeled values above 109 µg/m^3 (150 µg/m^3 with background) occurred at receptors less than 500 meters from the Dewey-Burdock Project boundary and the public road over which commuter traffic would access the project. ~~All receptor concentrations~~ at Wind Cave National Park were in compliance with the 24-hr NAAQS and the 24-hr, Class I PSD increment (Tables 6-1 and 6-2).

Avoid sentences that associate "compliance" with PSD increments.

Table 6-3: Top 20 Receptors, Annual Average PM_{10} Co

UTM Easting	UTM Northing	Maximum Modeled Concentration (µg/m^3)	PSD Class II ~~Standard~~ (µg/m^3)
582358	4810210	8.77	17
590758	4801610	8.61	17
583158	4809110	8.45	17
586258	4806010	8.43	17
590758	4802110	8.40	17
582258	4810310	8.26	17
582558	4809910	8.21	17
590758	4802010	8.06	17
590758	4801710	8.03	17
582158	4810410	8.02	17
589258	4802410	7.91	17
577137	4815932	7.89	17
582858	4809510	7.88	17
586958	4805710	7.86	17
585658	4806610	7.85	17
585358	4806910	7.82	17
585558	4806710	7.80	17
582131	4810420	7.80	17
587558	4805410	7.78	17
584458	4807710	7.77	17

Add a column to this table showing total concentration (modeled plus background). No comparisons to the NAAQS should be made unless the background concentration has been added to the modeled concentration.

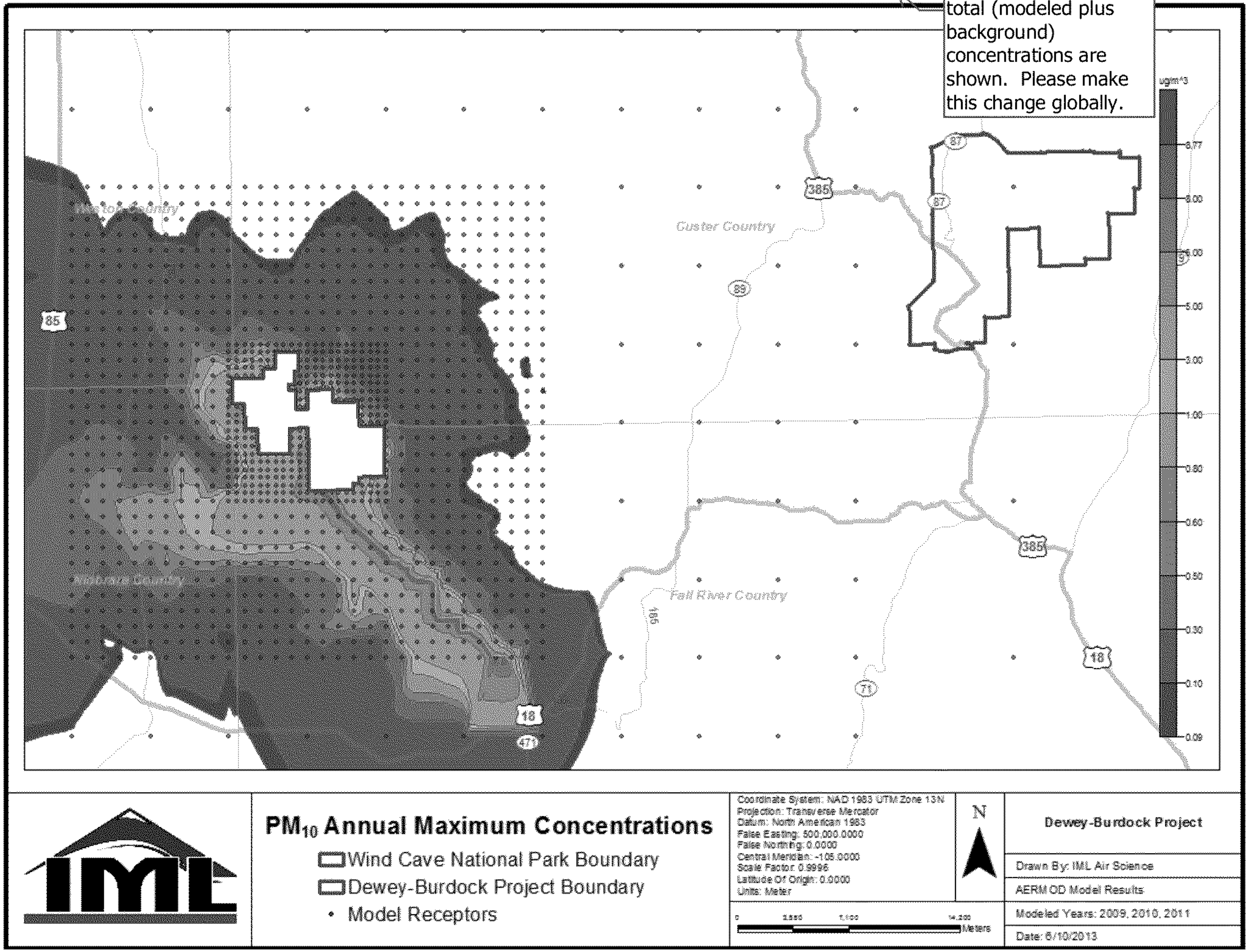
Table 6-4: Top 50 Receptors, 24-Hr Maximum PM_{10} Concentrations

UTM Easting	UTM Northing	Maximum Modeled Concentration (µg/m³)	NAAQS ~~Concentration~~ (µg/m³)
590758	4801610	187.22	150
589258	4802410	165.46	150
583158	4809110	159.01	150
586158	4806110	145.93	150
589158	4802510	145.34	150
587558	4805110	145.07	150
590758	4801710	144.29	150
586258	4806010	142.54	150
590658	4801610	142.13	150
589158	4802610	138.31	150
586058	4806210	135.01	150
585958	4806210	134.80	150
590658	4801710	134.65	150
586958	4805710	132.62	150
586058	4806110	131.81	150
589058	4802610	130.61	150
576358	4816649	128.57	150
590558	4801610	128.56	150
587658	4804910	125.31	150
590758	4801810	124.54	150
583158	4809010	123.62	150
587358	4805010	122.61	150
589158	4802410	122.38	150
590558	4801710	122.19	150
576358	4816610	121.24	150
587558	4805210	119.96	150
587458	4805210	119.52	150
585958	4806310	118.34	150
586858	4805710	117.47	150
577139	4815832	117.42	150
587558	4805010	117.39	150
590758	4802110	117.10	150
587458	4805310	116.32	150
576158	4816710	115.42	150
585858	4806410	114.51	150

582958	4809210	114.36	150
576258	4816710	114.04	150
587558	4804910	112.00	150
592658	4800010	111.51	150
583058	4809110	111.25	150
582658	4810210	110.84	150
577137	4815932	110.73	150
589158	4802710	110.19	150
589058	4802710	110.10	150
585358	4806910	109.96	150
576958	4815710	109.95	150
587458	4805110	109.92	150
587458	4805010	109.85	150
591158	4801810	109.49	150
586658	4806210	109.31	150

Figure 6-4. Annual Average PM_{10} Concentrations

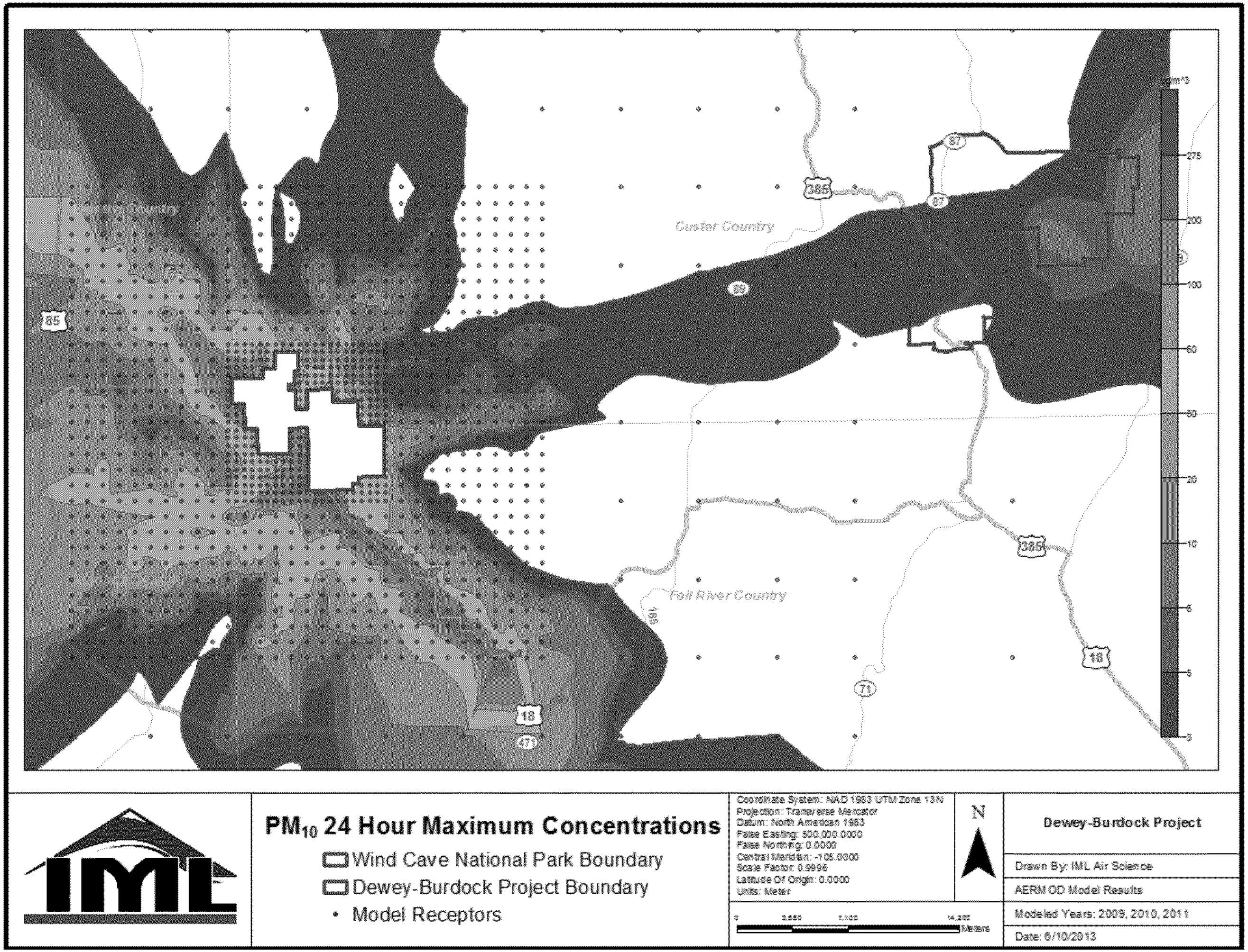
Please make sure the isopleth figure titles indicate whether modeled increases or total (modeled plus background) concentrations are shown. Please make this change globally.



ED_005364K_00015601-00061

Total or Modeled?

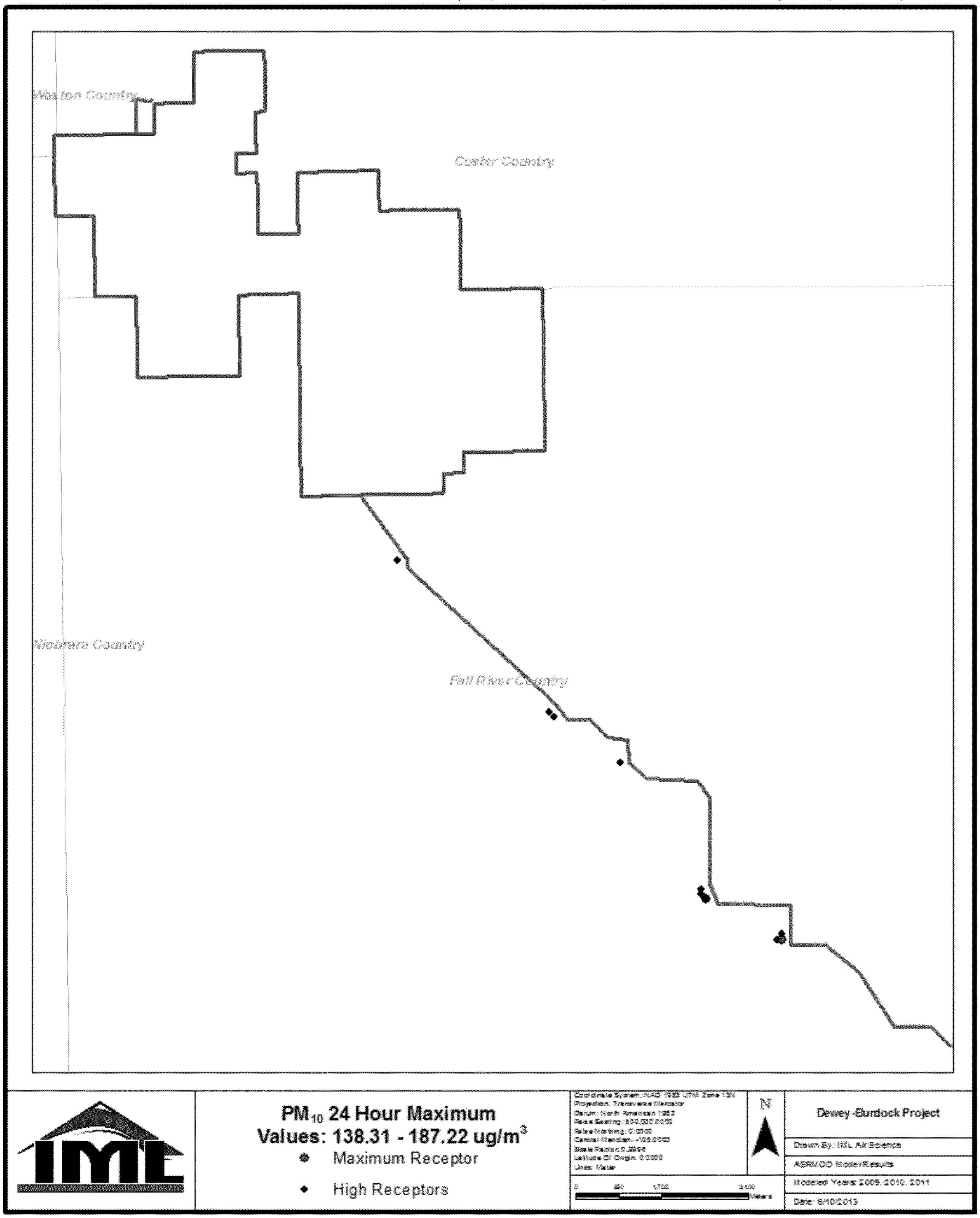
Figure 6-5. Maximum 24-Hour Average PM_{10} Concentrations



ED_005364K_00015601-00062

I suggest deleting this figure since this modeling over-predicts PM10 concentrations.

Figure 6-6. Modeled 24-Hour PM_{10} (Top 10 Receptors Without Dry Depletion)



6.2.1. PM_{10} Model Over-Prediction Problems

These modeling results ~~must be qualified by noting an inherent bias in the AERMOD model. Several studies have recognized~~ AERMOD's tendency to over-predict the transportability and the resultant air quality impacts of fugitive dust emissions (Cliffs 2011). Among several possible causes, predicted concentrations do not account for particle electrostatic agglomeration, enhanced gravitational settling and deposition near the point of release (AECOM 2012).

This tendency was exposed in ISCST3, the regulatory model that preceded AERMOD. Although AERMOD improved on many of ISCST3's features, these improvements were confined primarily to stationary sources and buoyant plumes. Even with the improvements to AERMOD, the problem of over-predicting 24-hr PM_{10} impacts from fugitive dust persists (Sullivan 2006). For low-level emission plumes, AERMOD has not been evaluated extensively by EPA for performance against measured data. In 2011 MMA conducted a modeling analysis to determine whether EPA's current model (AERMOD) would yield significant improvements over the ISC3 Short Term model in the prediction of short-term particulate concentrations for surface mining operations. The study found that AERMOD still over-predicts short-term PM_{10} concentrations, and even exceeds the predictions of ISCST3 at model receptors positioned from 100 to 500 meters from the sources of fugitive emissions (MMA 2011). The study concludes that AERMOD "consistently predicts concentrations higher than ISCST in the range of concentrations that would be critical decision points in the permitting process."

6.2.2. Refined PM_{10} Modeling Results

In an attempt to address the problem of over-predicting impacts from fugitive dust at the Dewey-Burdock project, AERMOD was re-run for impacts at select receptors using the dry depletion option. This option, also available with ISCST3, seeks to account for particulate deposition near the source. It requires the user to input particle densities and size distributions. The receptors modeled with dry depletion included all 50 receptors that, with background concentrations added, exceeded the 24-hr PM_{10} NAAQS in the initial model run. It was not realistic to use this option for the initial run, as modeling impacts on all receptors in the modeling domain would have required several hundred hours to execute.

Is this table needed?

With the dry depletion option enabled, AERMOD predicted significantly lower 24-hr PM_{10} impacts ~~as summarized in Table 6-5~~. The highest design-value concentration was reduced from 187.2 to 83.6 μg/m^3. With background added, all 50 receptors were ~~in compliance with~~ the NAAQS. The refined model ~~also showed 45 receptors with~~ 24-hour ~~impacts~~ greater than the Class II PSD increment of 30 μg/m^3~~. All 45 receptors fall~~ within 500 meters of the project boundary or the public road. ~~Figure 6-7 shows the locations of the top 10 receptors.~~

Although EPA decided to not make the dry deposition algorithm a regulatory default modeling option, it recommended its use in appropriate instances (EPA 2005) as enumerated below:

1. Large number of PM_{10} fugitive sources
2. Source emissions can be quantified
3. Settling and deposition are anticipated to occur
4. A refined modeling analysis is being conducted

The Dewey-Burdock Project meets all of these criteria, as detailed in the modeling protocol (Section 3.9) above.

Notwithstanding the uncertainties in modeling short-term impacts from fugitive dust sources, Powertech intends to adopt several control strategies to reduce actual impacts:

1. Apply water spray frequently to project-area roads and exposed areas
2. Reduce commuter traffic over the unpaved county road by providing company vans and incentivizing carpool arrangements
3. Install particulate monitors as needed to determine background ambient air quality and downwind impacts from the project
4. Assist Fall River County with maintenance and the application of dust suppressant on the unpaved public road

The modeling results reported here already incorporate the first two strategies. The third strategy will eventually enable the evaluation of short-term dispersion model performance. The fourth strategy has been initiated under a cooperative agreement between Powertech and the County.

Suggest deleting this table. If not deleted, add a column showing total concentrations

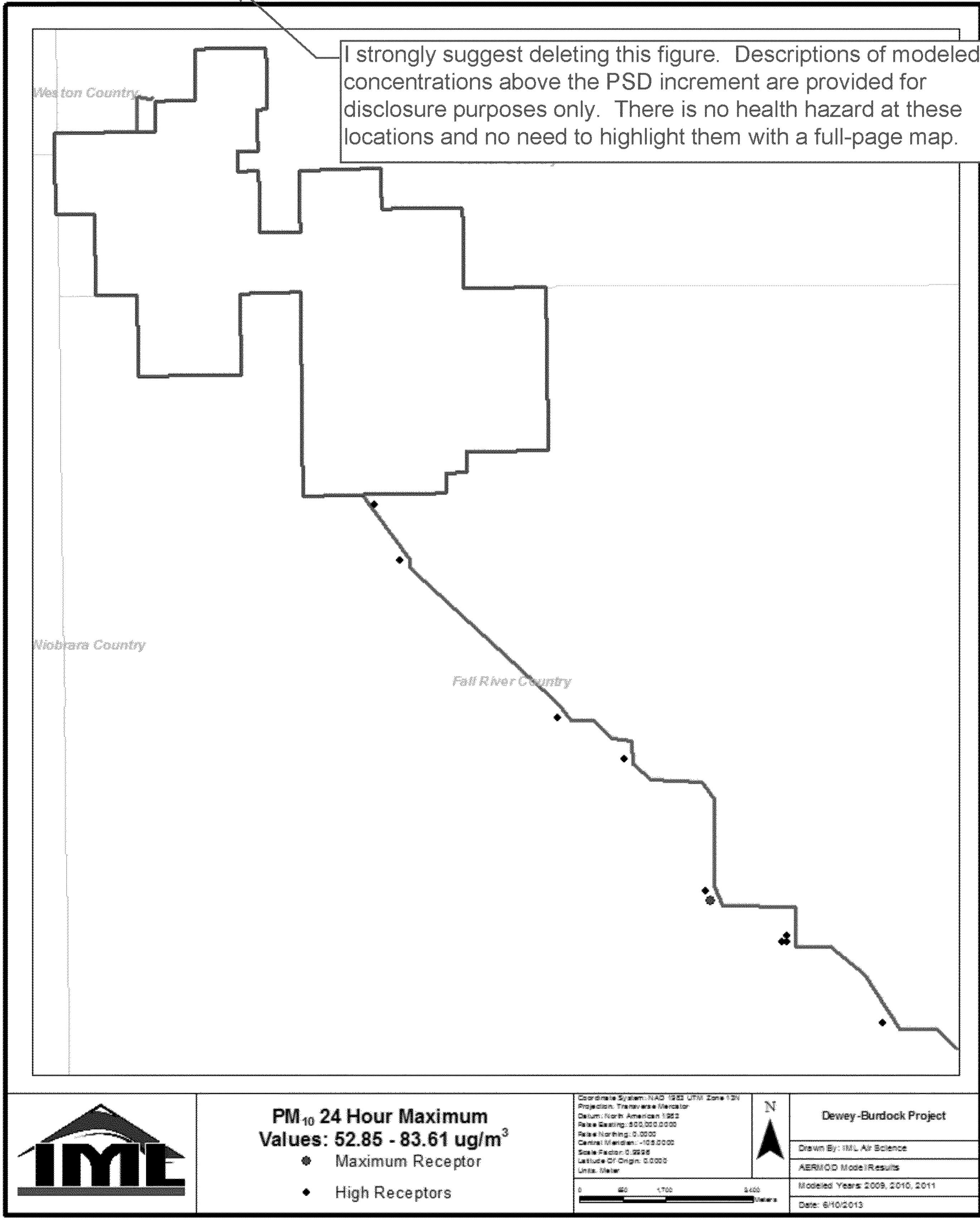
Table 6-5: Top 50 Receptors, 24-Hr Maximum PM_{10} Values With Dry Depletion

UTM Easting	UTM Northing	Maximum Modeled Concentration (µg/m^3)	NAAQS ~~Concentration~~ (µg/m^3)
589258	4802410	83.61	150
590758	4801610	74.48	150
582658	4810210	65.34	150
583158	4809110	63.91	150
590658	4801610	61.24	150
590758	4801710	59.36	150
592658	4800010	57.63	150
586258	4806010	54.52	150
589158	4802610	53.12	150
587558	4805210	52.85	150
583158	4809010	51.98	150
590758	4801810	51.54	150
589158	4802710	50.37	150
590658	4801710	49.92	150
586158	4806110	49.43	150
587558	4805110	48.00	150
583058	4809110	47.60	150
586658	4806210	47.38	150
589158	4802510	47.29	150
590758	4802110	47.10	150
586958	4805710	46.85	150
577137	4815932	46.30	150
587658	4804910	45.86	150
590558	4801610	44.77	150
585358	4806910	44.51	150
586058	4806110	43.94	150
586058	4806210	43.91	150
586858	4805710	42.19	150
589158	4802410	42.19	150
585958	4806310	42.12	150
587458	4805310	41.96	150
577139	4815832	40.60	150
585858	4806410	40.42	150
585958	4806210	40.23	150
590558	4801710	38.86	150
587558	4805010	38.64	150
589058	4802710	37.76	150

582958	4809210	37.27	150
591158	4801810	36.19	150
587558	4804910	35.64	150
587458	4805210	34.62	150
589058	4802610	33.87	150
587458	4805110	33.30	150
576958	4815710	32.48	150
587458	4805010	32.09	150
587358	4805010	28.80	150
576358	4816610	25.41	150
576358	4816649	24.41	150
576258	4816710	22.48	150
576158	4816710	20.99	150

Figure 6-7. Modeled 24-Hour PM_{10} (Top 10 Receptors With Dry Depletion)

I strongly suggest deleting this figure. Descriptions of modeled concentrations above the PSD increment are provided for disclosure purposes only. There is no health hazard at these locations and no need to highlight them with a full-page map.



ED_005364K_00015601-00068

6.3. $PM_{2.5}$ Modeling Analysis

Particulate matter in the form of $PM_{2.5}$ emissions were modeled in a similar fashion to PM_{10} emissions. The primary source of $PM_{2.5}$ emissions will be the smaller fugitive dust particles generated by traffic on unpaved roads, road maintenance, drilling and construction activities, and wind erosion on disturbed areas. A small fraction of the total $PM_{2.5}$ emissions will be generated by internal engine fuel combustion.

The maximum yearly $PM_{2.5}$ emissions from the Dewey-Burdock Project were modeled for potential impacts on ambient air quality at all receptors in the modeling domain. Both on-site and off-site, project-related emission sources were included in the model. Variable emission rates were used based on month, day and hour. The model produced maximum receptor concentrations for any calendar day (24-hr average) and for the entire modeling period (annual average). The 24-hour design value was computed for each receptor as the three-year average of the 8th high (98th percentile) concentration.

There is no need for these tables. Please describe the results (move description up from page 64). For example, the maximum modeled PM2.5 concentration is approximately 25 percent of the PSD Class II increment. Add description of the NAAQS comparison.

6.3.1. $PM_{2.5}$ Modeling Results

Results from the AERMOD model run are presented below. ~~Tab~~ ~~receptors ranked by annual average concentrations. Table 6-7 li~~ ~~ranked by 24-hour maximum concentrations.~~ Figure 6-8 is an iso the annual impacts from the Dewey-Burdock Project. Figure 6-9 is an isopleth map of the maximum 24-hr impacts from the Dewey-Burdock Project.

Delete this table.

~~6-6.~~ Top 20 Receptors, Annual Average $PM_{2.5}$ Values

UTM Easting	UTM Northing	Maximum Modeled Concentration (µg/m³)	PSD Class II ~~Standard~~ (µg/m³)
577137	4815932	1.02	4
577067	4815933	0.94	4
577139	4815832	0.94	4
582358	4810210	0.92	4
577058	4815910	0.92	4
582258	4810310	0.88	4
576967	4815934	0.88	4
590758	4801610	0.87	4
583158	4809110	0.87	4
582158	4810410	0.86	4
586258	4806010	0.86	4

582558	4809910	0.86	4
576958	4815910	0.85	4
590758	4802110	0.85	4
577058	4815810	0.85	4
582131	4810420	0.84	4
577141	4815732	0.84	4
590758	4802010	0.82	4
590758	4801710	0.82	4
[illegible]358	4809510	0.82	4

I strongly suggest that this table be deleted. It does not compare total predicted concentrations to the NAAQS.

Table 6-7. Top 50 Receptors, 24-Hr Maximum $PM_{2.5}$ Values

[illegible]M [illegible]ing	UTM Northing	Maximum Modeled Concentration (µg/m³)	NAAQS ~~Concentration~~ (µg/m³)
[illegible]137	4815932	6.90	35
582358	4810210	6.69	35
583158	4809110	6.65	35
582158	4810410	6.55	35
582131	4810420	6.47	35
577139	4815832	6.45	35
590758	4801610	6.45	35
577067	4815933	6.45	35
582258	4810310	6.42	35
582558	4809910	6.38	35
577058	4815910	6.33	35
583258	4808810	6.27	35
589158	4803410	6.20	35
589158	4803310	6.15	35
585658	4806610	6.10	35
584458	4807710	6.07	35
586258	4806010	6.03	35
590758	4802010	5.98	35
583358	4808710	5.98	35
583458	4808610	5.94	35
589358	4802210	5.93	35
577141	4815732	5.92	35
590758	4802110	5.91	35
577058	4815810	5.91	35
576967	4815934	5.89	35

589158	4803510	5.89	35
582458	4810010	5.87	35
590758	4801910	5.86	35
582058	4810410	5.84	35
583058	4809210	5.84	35
590758	4801510	5.84	35
576958	4815910	5.84	35
582158	4810310	5.78	35
589258	4802410	5.78	35
585758	4806510	5.76	35
590458	4802110	5.76	35
582758	4809610	5.75	35
584558	4807610	5.75	35
590758	4801810	5.74	35
582858	4809510	5.74	35
583158	4809010	5.73	35
585858	4806410	5.73	35
582031	4810418	5.73	35
583158	4808910	5.72	35
584258	4807910	5.72	35

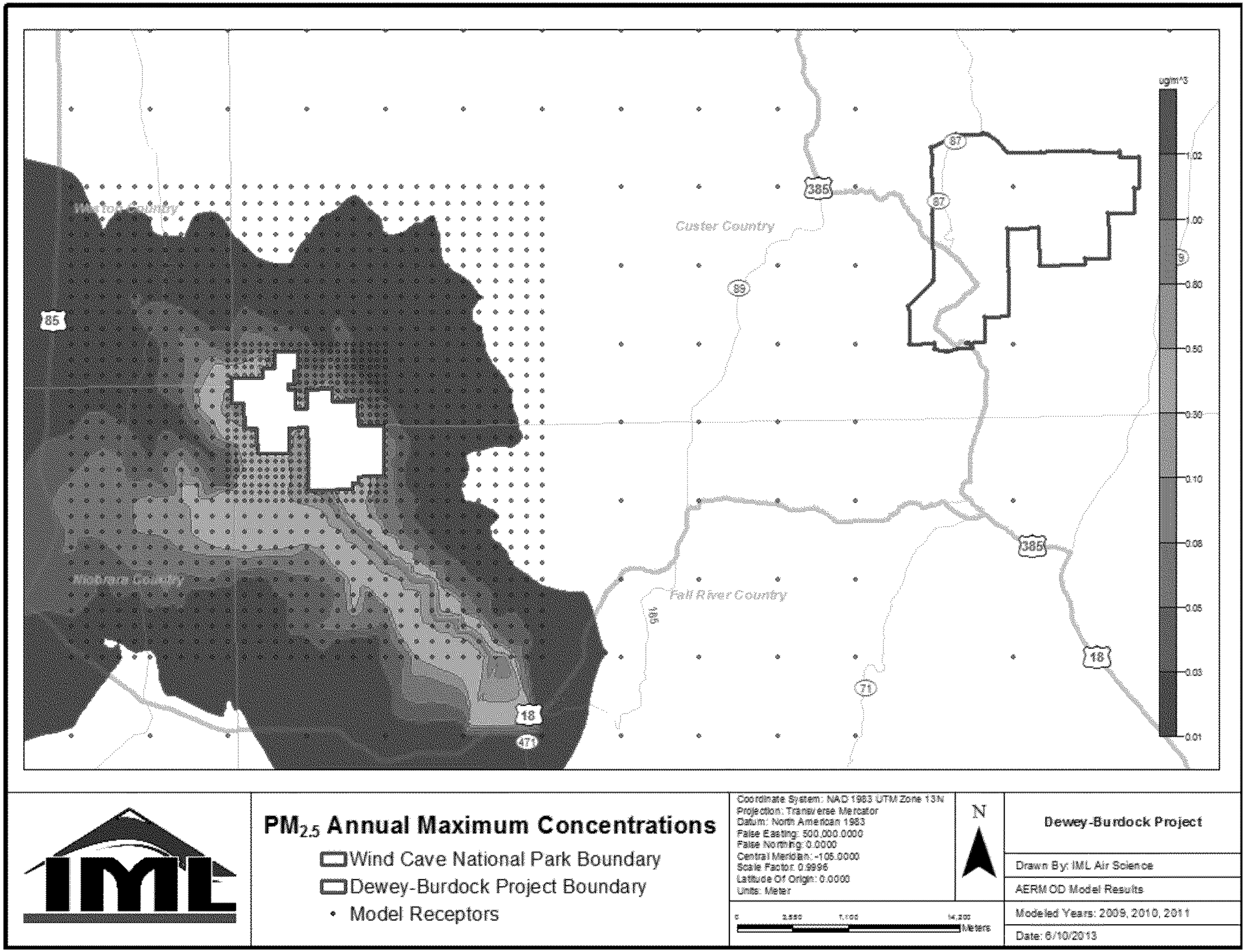
Please be more careful with wording. "Tables" do not predict compliance, modeling does. Also note that "receptors" do not "comply" with NAAQS. Do not use the word "comply" in conjunction with the PSD increments. Give readers an idea of the modeled total concentration relative to the NAAQS (perhaps a percentage based on maximum modeled value). You might state that XX% of the predicted concentrations are below XX% of the NAAQS. Tables 6-6 and 6-7 do not add to reader understanding.

Table 6-6 predicts that all receptors comply with the annual NAAQS (12 μg/m^3) and PSD Class II increment. This is confirmed graphically in Figure 6-8. Table 6-7 predicts that all receptors comply with the 24-hour NAAQS (35 μg/m^3) and PSD Class II increment of 9 μg/m^3. AERMOD also predicts that all receptors at Wind Cave National Park will comply with the NAAQS and the Class I PSD increment (2 μg/m^3). This is confirmed graphically in Figure 6-9. After adding background to modeled concentrations, all receptors are still in compliance with the annual and 24-hour NAAQS (Table 6-1).

With AERMOD, the only way to predict NAAQS compliance is to include background concentrations.

Total or Modeled?

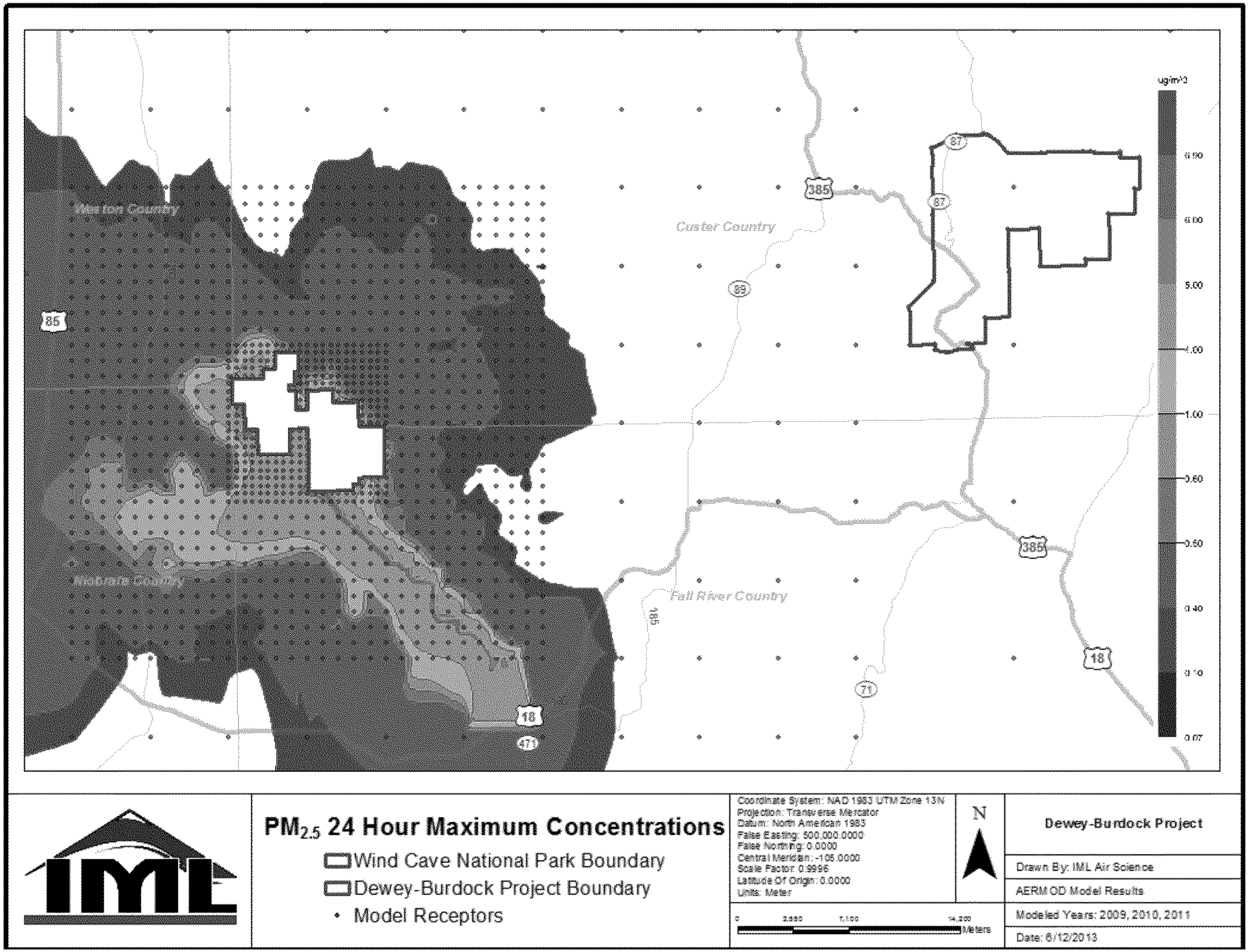
Figure 6-8. Annual $PM_{2.5}$ Concentrations



ED_005364K_00015601-00072

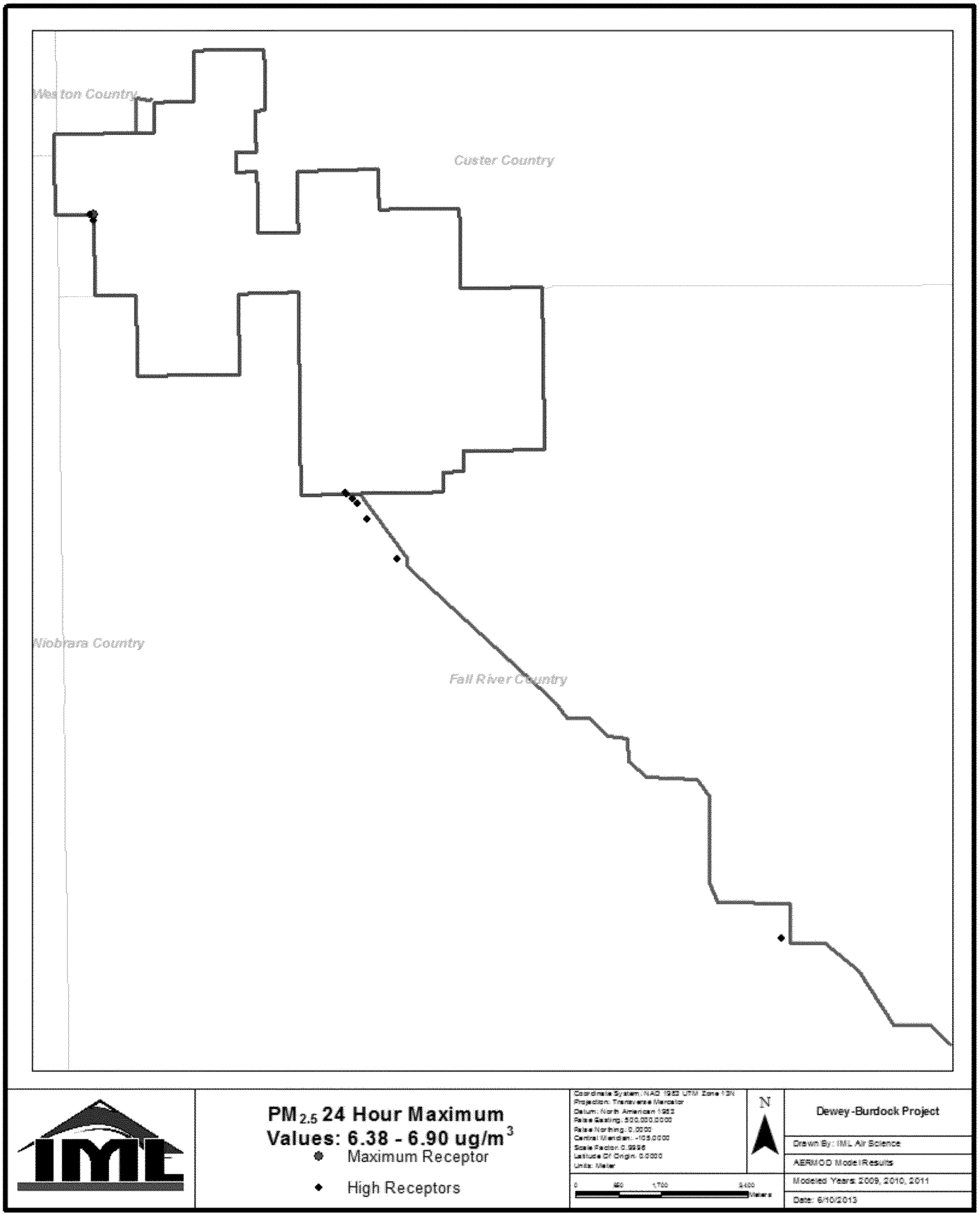
Total or Modeled?

Figure 6-9. Maximum 24-Hour $PM_{2.5}$ Concentrations



Suggest deleting this figure.

Figure 6-10. Modeled 24-Hour $PM_{2.5}$ (Top 10 Receptors)



6.4. NO_2 Modeling Analysis

NO_2 emissions are derived from oxides of nitrogen (NO_x), at an assumed conversion ratio of 75%. The primary source of NO_x emissions will be internal engine fuel combustion from mobile and stationary sources.

The maximum yearly NO_x emissions from the Dewey-Burdock Project were modeled for potential impacts on ambient air quality at all receptors in the modeling domain. Both on-site and off-site, project-related emission sources were included in the model. Variable emission rates were used based on month, day and hour. The model produced maximum hourly receptor concentrations by calendar day, the 98^{th} percentile of these daily maxima for each year, and the three-year average of the 98^{th} percentiles. It also produced the average receptor concentrations for the entire modeling period (annual average).

Results from the AERMOD model run are presented below. Table 6-8 lists the top 20 receptors ranked by annual average concentrations. ~~Table 6-9 lists the top 50 receptors ranked according to the 1-hr design value.~~ Figure 6-11 is an isopleth, or contour plot of the annual impacts from the Dewey-Burdock Project. Figure 6-12 is an isopleth map of the 98^{th} percentile 1-hr impacts from the Dewey-Burdock Project. ~~Figure 6-13 shows the locations of the top 1-hr receptor concentrations. The top 10 values all occurred within a small area along the project boundary.~~ AERMOD predicts that all receptors will comply with all relevant NAAQS and ~~all PSD standards. After adding background to modeled concentrations, all receptors are still in compliance with the annual and 1-hour NAAQS (Table 6-1).~~

Please delete table.

Table 6-8: Top 20 Receptors, Annual Average NO_2

UTM Easting	UTM Northing	Maximum Modeled Concentration (µg/m³)	PSD Class II ~~Standard~~ (µg/m³)
577137	4815932	1.08	25
577139	4815832	1.02	25
577067	4815933	0.98	25
577058	4815910	0.96	25
577141	4815732	0.94	25
577058	4815810	0.91	25
577143	4815632	0.89	25
576967	4815934	0.88	25
577058	4815710	0.87	25
576958	4815910	0.86	25
576958	4815810	0.83	25
577058	4815610	0.82	25
576958	4815710	0.82	25
577144	4815532	0.79	25
576958	4815610	0.77	25
576867	4815935	0.77	25
576858	4815910	0.76	25
576858	4815810	0.76	25
577058	4815510	0.75	25
576858	4815710	0.75	25

Please delete table.

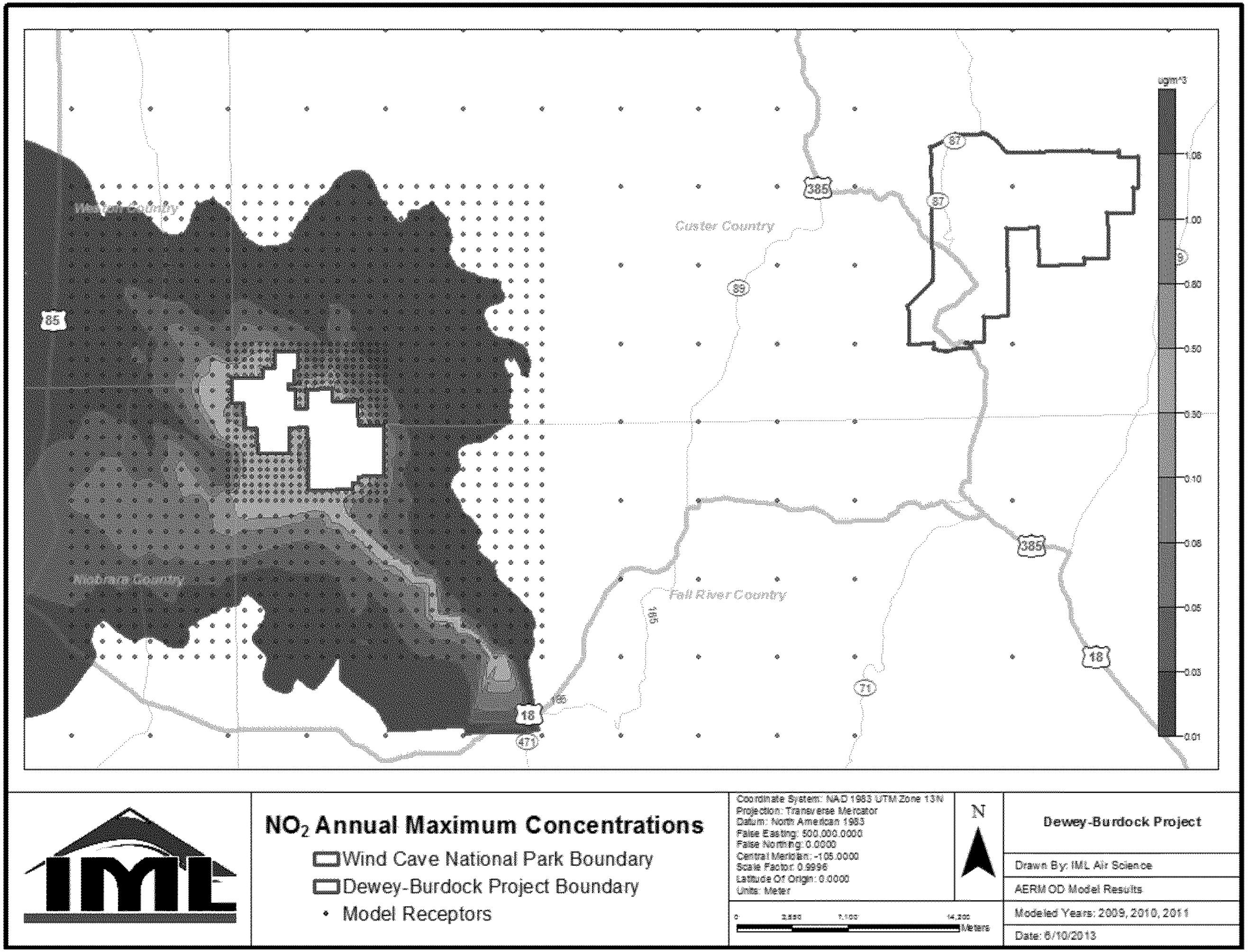
Table 6-9: Top 50 Receptors, 98th percentile of Daily Maximum 1-Hr NO_2 Values

UTM Easting	UTM Northing	Maximum Modeled Concentration (µg/m³)	NAAQS Concentration (µg/m³)
577137	4815932	156.85	187
577139	4815832	151.35	187
577067	4815933	142.05	187
577141	4815732	138.49	187
577058	4815910	138.28	187
577058	4815810	132.67	187
577143	4815632	131.58	187
577058	4815710	128.67	187
576967	4815934	128.45	187
576958	4815910	125.09	187
577058	4815610	123.79	187
577144	4815532	122.47	187

576867	4815935	118.35	187
576958	4815810	118.20	187
577058	4815510	118.08	187
576958	4815710	117.01	187
576958	4815610	116.58	187
576858	4815910	113.70	187
576958	4815510	112.65	187
576858	4815710	107.63	187
576958	4815410	105.71	187
576858	4815810	103.57	187
576858	4815510	103.56	187
576858	4815410	102.67	187
576767	4815935	102.12	187
576758	4815910	101.78	187
577146	4815432	101.68	187
576858	4815610	101.52	187
577058	4815410	100.81	187
577148	4815332	100.01	187
576758	4815410	96.17	187
576758	4815510	96.04	187
576758	4815610	94.22	187
576758	4815710	93.59	187
576858	4815310	93.40	187
576358	4816310	93.16	187
576358	4816410	93.03	187
576667	4815936	92.75	187
577058	4815310	92.66	187
576758	4815310	92.43	187
576362	4816349	92.30	187
576758	4815810	92.13	187
577149	4815232	91.21	187
576361	4816449	90.68	187
576958	4815310	89.91	187
576658	4815310	89.60	187
576567	4815937	89.12	187
576658	4815410	89.07	187
576658	4815910	88.39	187
577151	4815132	88.25	187

Modeled or Total?

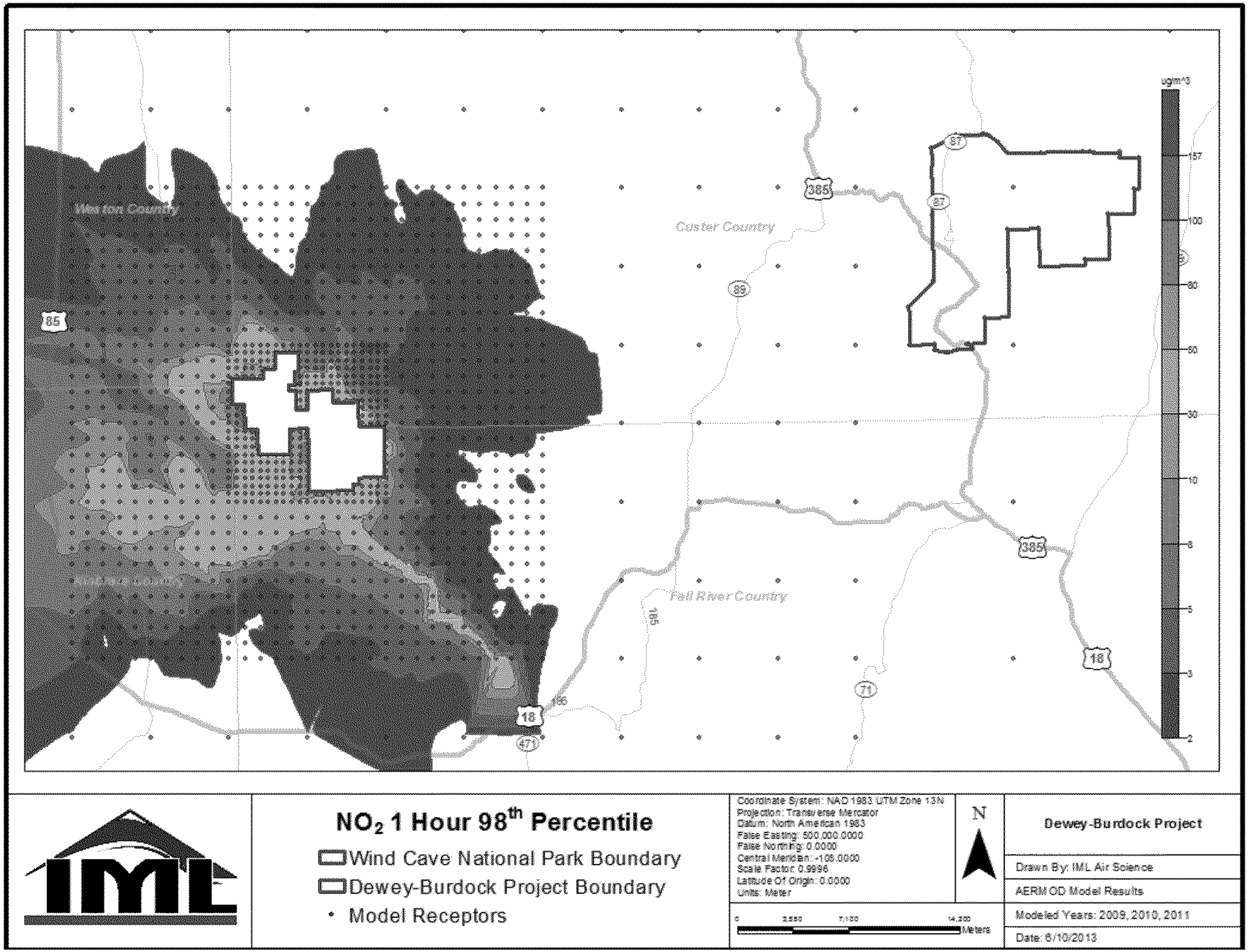
Figure 6-11. Annual NO_2 Concentrations



ED_005364K_00015601-00078

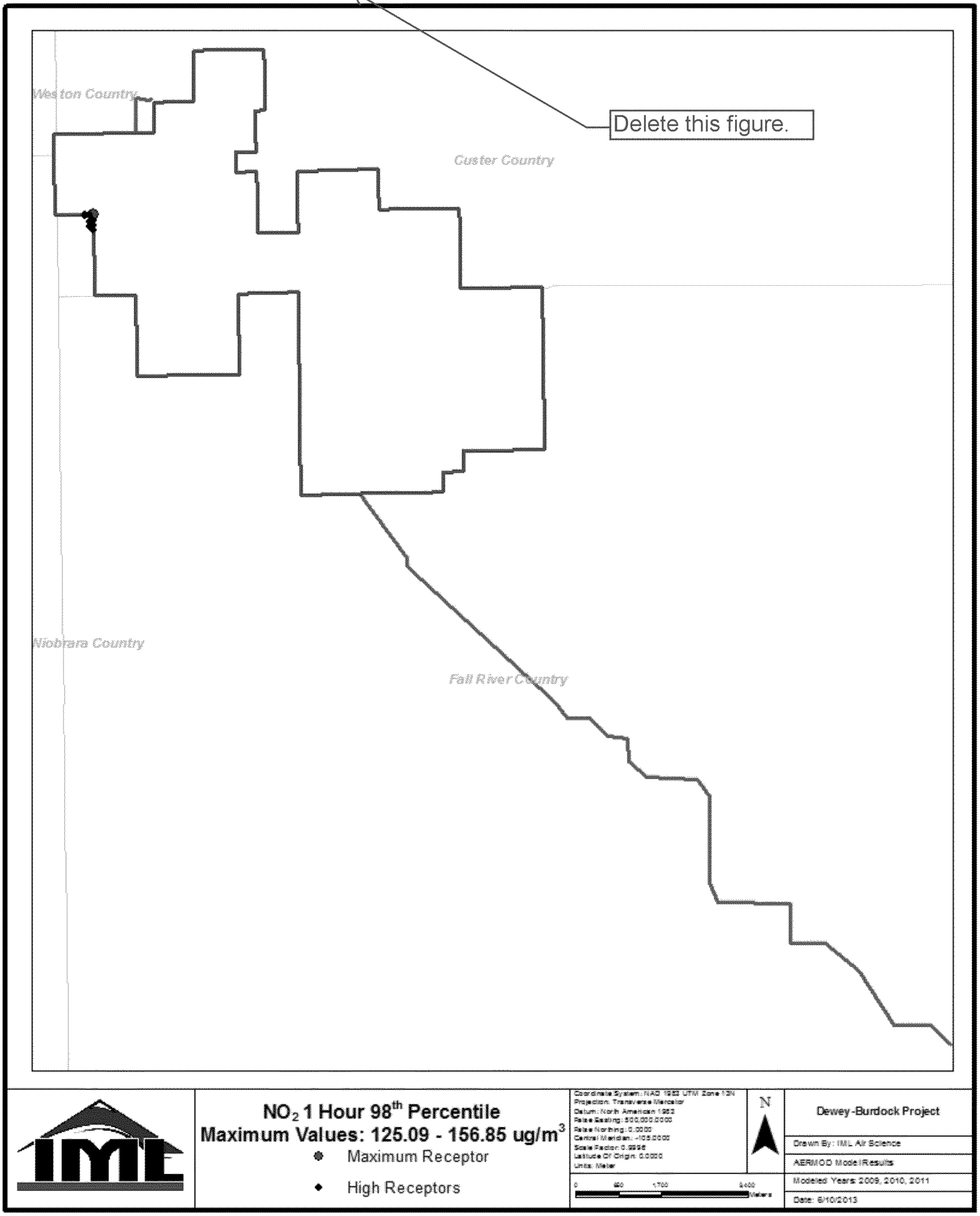
Modeled or Total?

Figure 6-12. Modeled 98th Percentile 1-Hr NO_2 Concentrations



ED_005364K_00015601-00079

Figure 6-13. Modeled 1-Hour NO_2 (Top 10 Receptors)



6.5. SO_2 Modeling Analysis

The primary source of SO_2 emissions from the Dewey-Burdock project will be internal engine fuel combustion from mobile and stationary sources.

The maximum yearly SO_2 emissions from the Dewey-Burdock Project were modeled for potential impacts on ambient air quality at all receptors in the modeling domain. Both on-site and off-site, project-related emission sources were included in the model. Variable emission rates were used based on month, day and hour. The model produced maximum hourly receptor concentrations by calendar day, the 99th percentile of these daily maxima by year, and the three-year average of the 99th percentiles. It also produced 3-hr maxima, 24-hr maxima, and the average receptor concentrations for the entire modeling period (annual average).

Results from the AERMOD model run are presented below. ~~All~~ receptors, including those at Wind Cave National Park, ~~were compliant with the appropriate standards~~. The 24-hr and annual average values were all very near zero. ~~Table 6-10 lists the top 20 receptors ranked by 3-hr average concentrations. Table 6-11 lists the top 50 receptors ranked by 3-year average of the 1-hour maximum (99th percentile) concentrations.~~ Figure 6-14 is an isopleth, or contour plot of the annual impacts from the Dewey-Burdock Project. Figure 6-15 is an isopleth map of the maximum 24-hr impacts. Figure 6-16 is an isopleth map of the maximum 3-hr impacts. Figure 6-17 is an isopleth map of the 99th percentile 1-hr impacts. ~~AERMOD predicts that all receptors will comply with all relevant NAAQS and all PSD standards. After adding background to modeled concentrations, all receptors are still in compliance with the 3-hour and 1-hour NAAQS (Table 6-1).~~

Delete this table.

Table 6-10: Top 20 Receptors, 3-Hr Maximum SO_2

UTM Easting	UTM Northing	Maximum Modeled Concentration (µg/m³)	PSD Class II ~~Standard~~ (µg/m³)
576358	4816510	100.08	1300
576359	4816549	95.83	1300
576258	4816510	94.30	1300
576361	4816449	89.64	1300
576058	4816610	87.18	1300
576158	4816510	86.73	1300
576158	4816610	86.73	1300
576258	4816610	82.47	1300
576358	4816610	82.47	1300
575958	4816610	81.97	1300
576358	4816410	80.79	1300
576058	4816510	78.35	1300
575858	4816610	77.22	1300
576358	4816649	75.45	1300
575858	4816710	74.59	1300
581227	4810706	72.73	1300
576258	4816410	71.61	1300
581158	4810710	71.35	1300
581226	4810806	70.92	1300
575958	4816710	70.63	1300

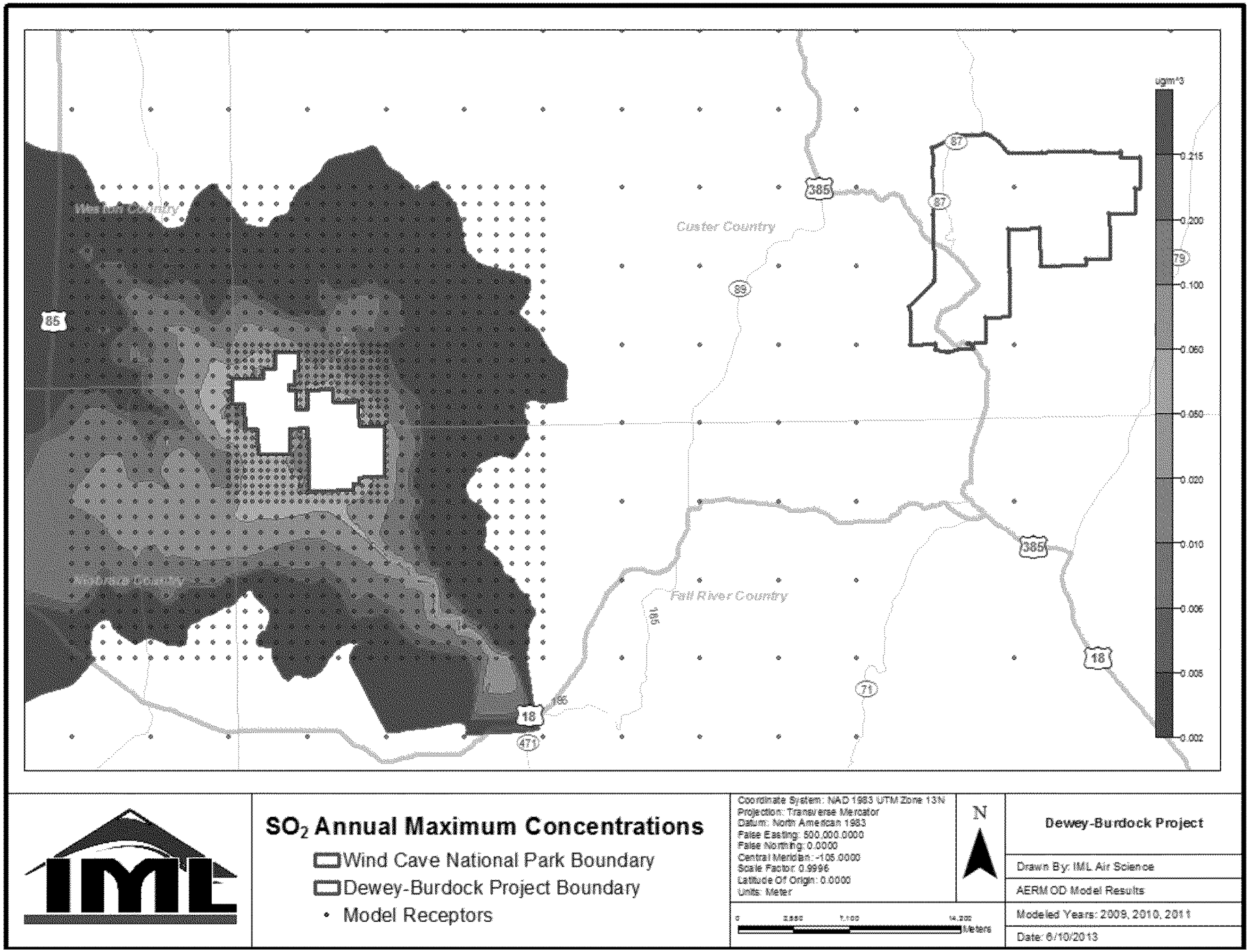
Delete this table

Table 6-11: Top 50 Receptors, 99th percentile of Daily Maximum 1-Hr SO_2 Values

UTM Easting	UTM Northing	Maximum Modeled Concentration (µg/m³)	NAAQS ~~Concentration~~ (µg/m³)
577137	4815932	48.26	200
577139	4815832	46.23	200
577067	4815933	43.74	200
577058	4815910	43.43	200
577143	4815632	42.55	200
577141	4815732	41.90	200
577058	4815810	40.90	200
576967	4815934	40.49	200
577058	4815710	39.75	200
576958	4815910	38.99	200
576358	4816610	38.80	200
576958	4815710	38.55	200
577058	4815610	38.30	200
576258	4816610	38.30	200

576867	4815935	37.78	200
576958	4815810	37.46	200
577144	4815532	36.86	200
576359	4816549	36.72	200
576858	4815910	36.59	200
576958	4815610	35.92	200
576858	4815710	35.23	200
577058	4815510	35.19	200
576358	4816649	35.03	200
576958	4815510	34.05	200
576767	4815935	33.84	200
576858	4815810	33.51	200
576758	4815910	33.50	200
576858	4815610	33.37	200
577146	4815432	32.72	200
577148	4815332	32.66	200
576858	4815510	32.17	200
577058	4815410	31.63	200
576958	4815410	31.34	200
577058	4815310	31.27	200
576758	4815610	31.14	200
576358	4816510	31.04	200
576758	4815510	30.89	200
576858	4815410	30.82	200
576958	4815310	30.62	200
576758	4815810	30.51	200
576361	4816449	30.45	200
576158	4816610	30.22	200
575958	4816710	29.80	200
576058	4816710	29.68	200
576158	4816710	29.37	200
576958	4815210	29.16	200
576658	4815810	29.10	200
576758	4815710	29.07	200
576758	4815410	28.78	200

Figure 6-14. Modeled Annual SO_2 Concentrations



ED_005364K_00015601-00084

Figure 6-15. Modeled Maximum 24-Hour SO_2 Concentrations

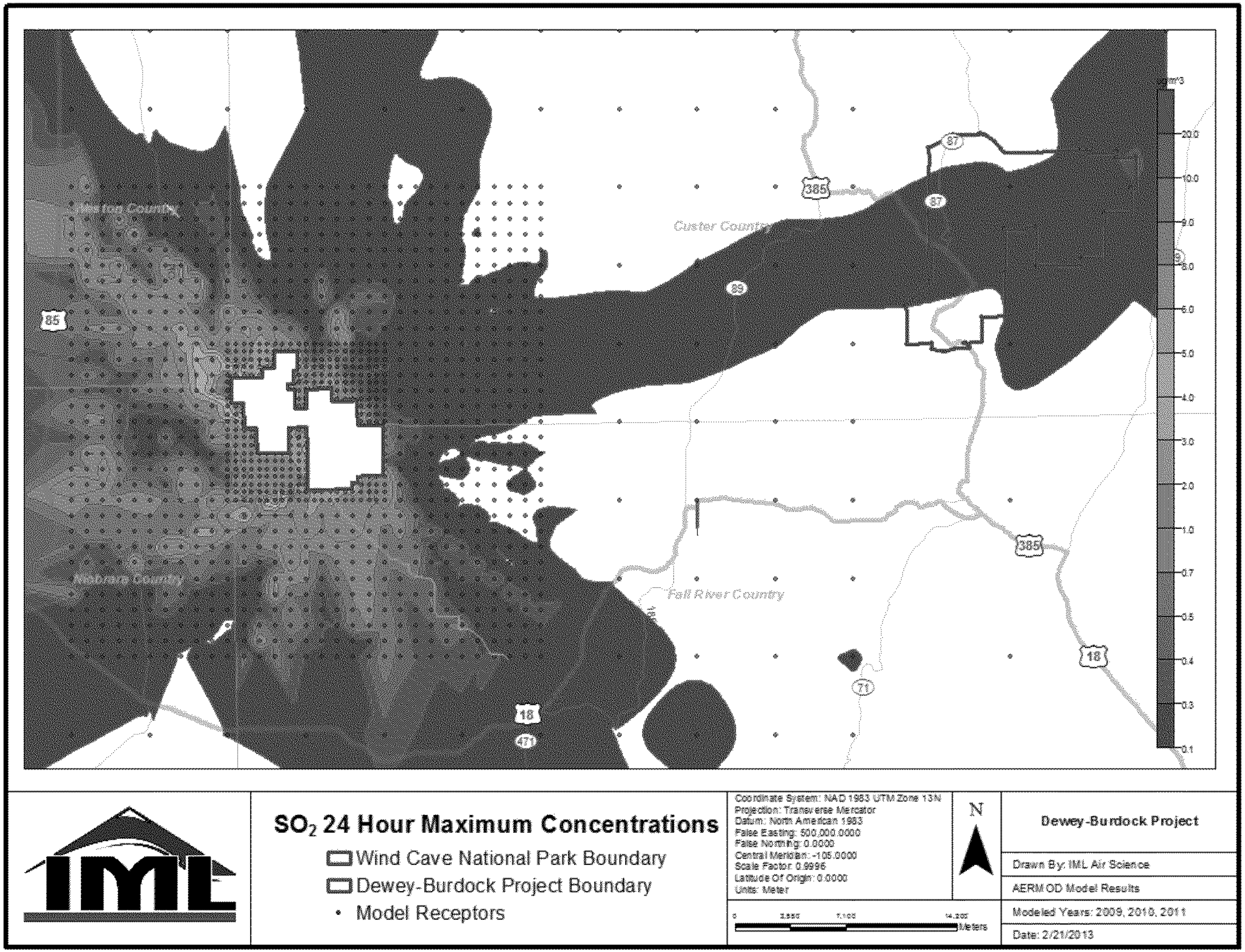
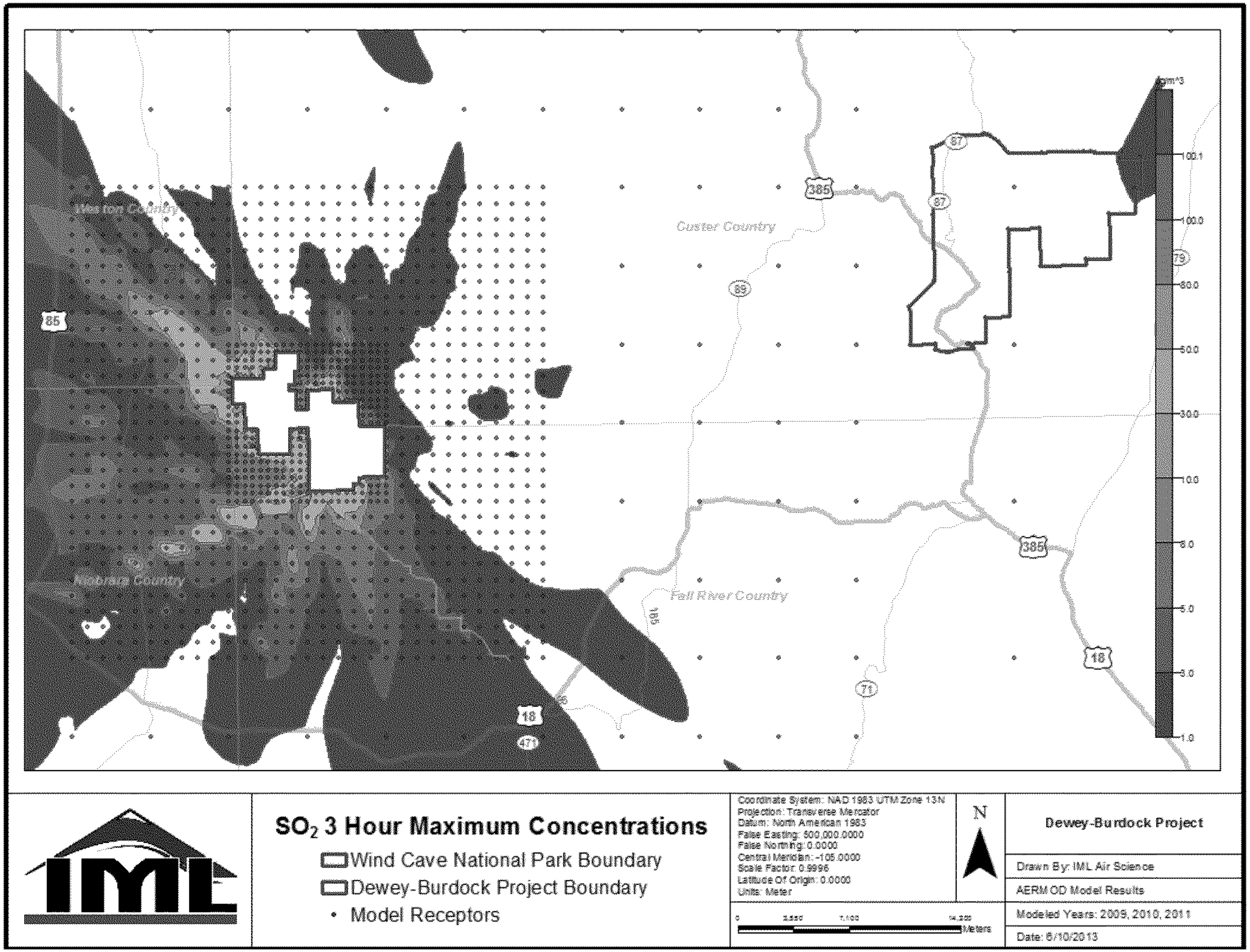
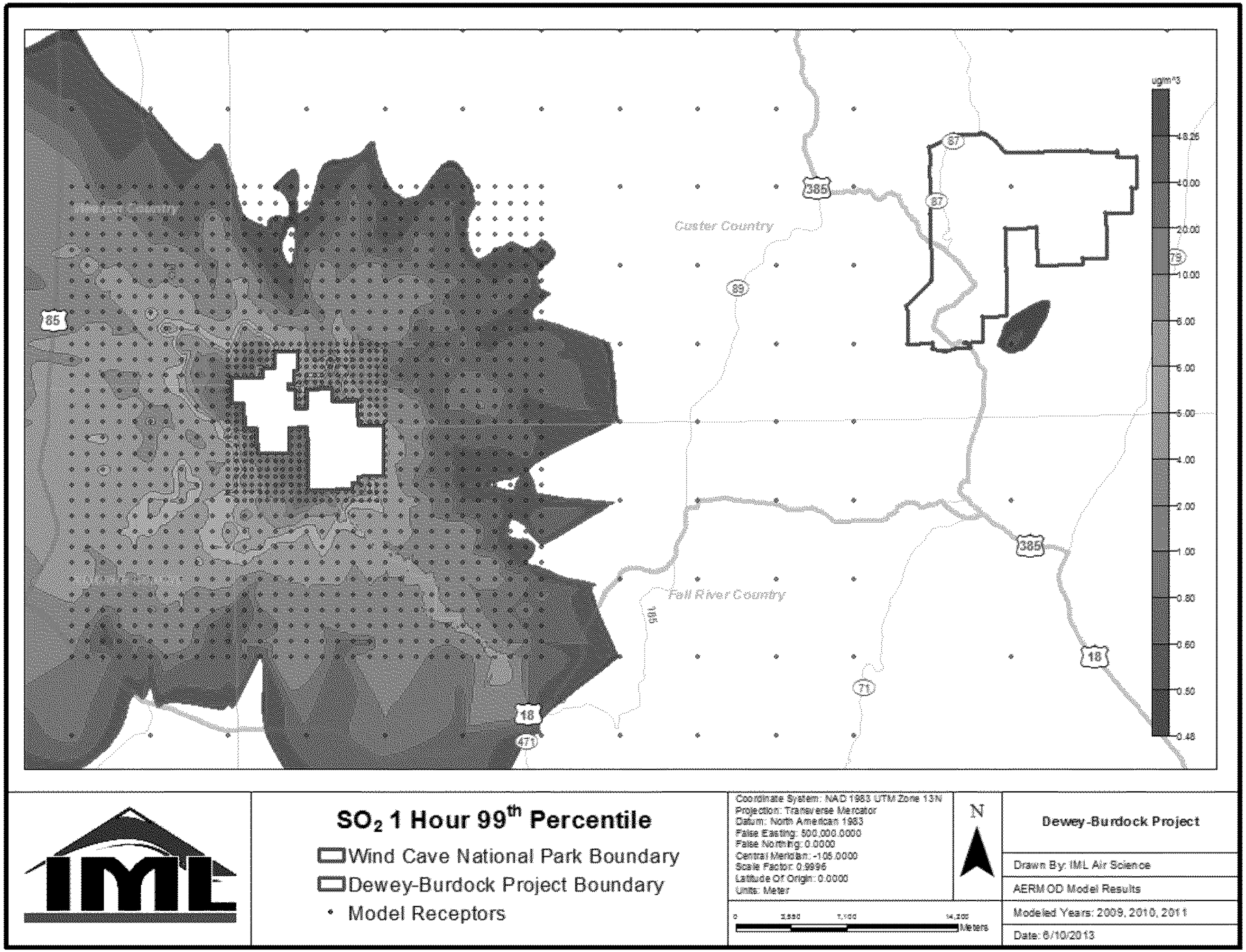


Figure 6-16. Modeled Maximum 3-Hour SO_2 Concentrations



ED_005364K_00015601-00086

Figure 6-17. Modeled 99th Percentile 1-Hour SO_2 Concentrations



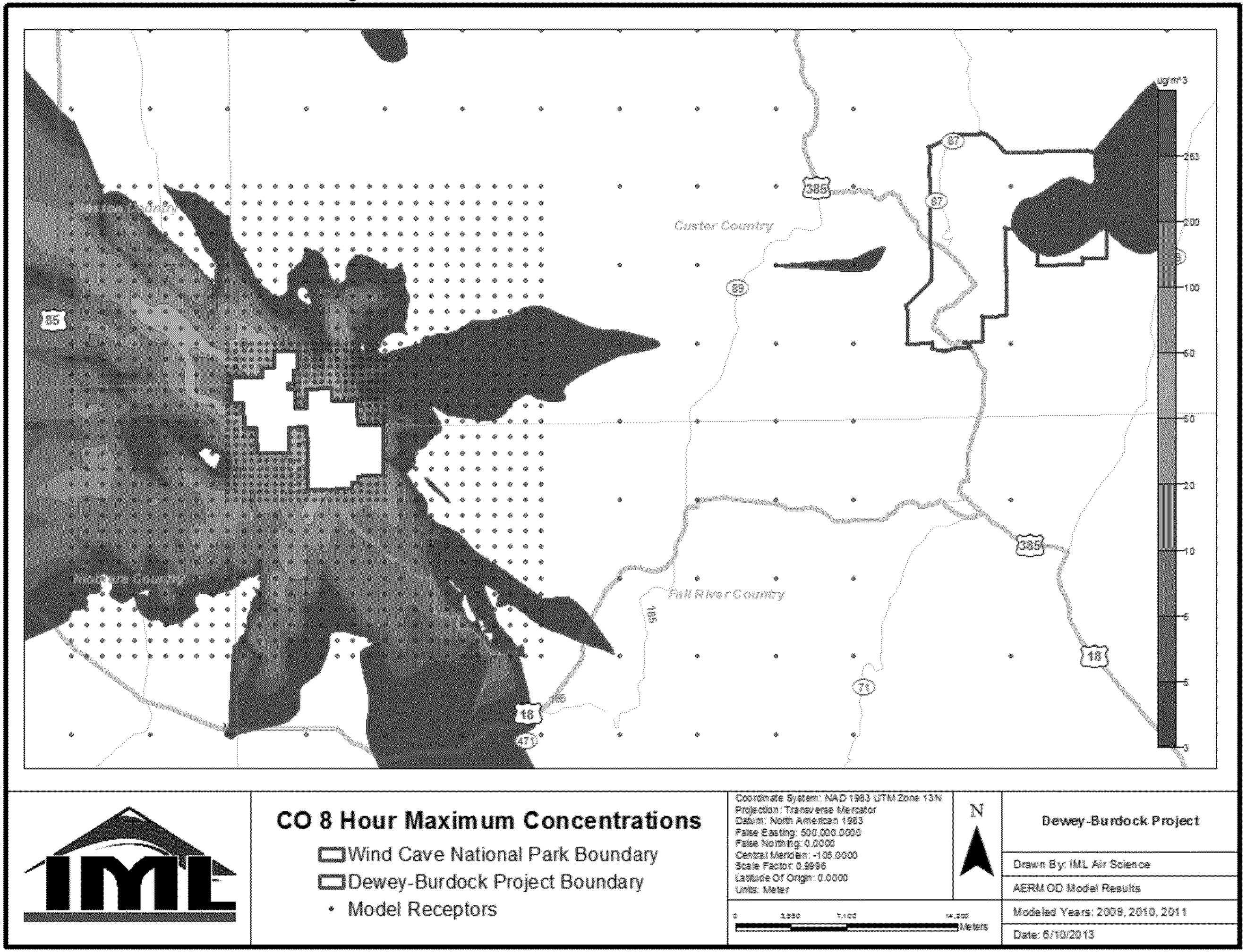
6.6. CO Modeling Analysis

The primary source of CO emissions from the Dewey-Burdock project will be internal engine fuel combustion from mobile and stationary sources.

The maximum yearly CO emissions from the Dewey-Burdock Project were modeled for potential impacts on ambient air quality at all receptors in the modeling domain. Both on-site and off-site, project-related emission sources were included in the model. Variable emission rates were used based on month, day and hour. The model produced maximum 1-hr and 8-hr receptor concentrations over the 3-year modeling period.

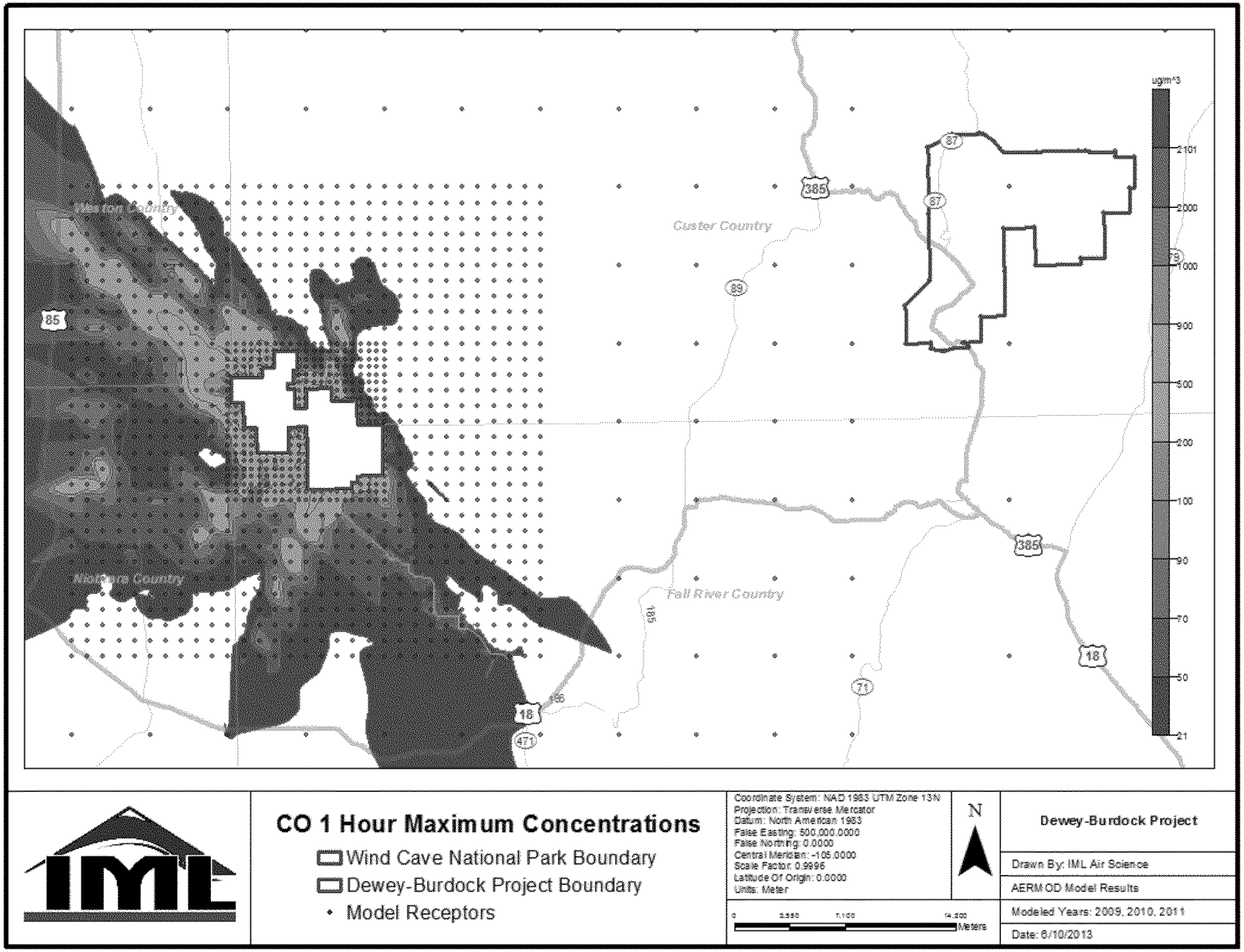
Results from the AERMOD model run are illustrated below. ~~All~~ receptors, including those at Wind Cave National Park, were ~~compliant with~~ the applicable standards. As shown in Table 6-1, all modeled concentrations of CO constituted a small fraction of the NAAQS, and are therefore not tabulated separately. Figure 6-18 is an isopleth, or contour plot of the maximum 8-hr impacts from the Dewey-Burdock Project. Figure 6-19 is an isopleth map of the maximum 1-hr impacts.

Figure 6-18. Modeled Maximum 8-Hr CO Concentrations



ED_005364K_00015601-00089

Figure 6-19. Modeled Maximum 1-Hr CO Concentrations



ED_005364K_00015601-00090

This sentence is incorrect The purpose is to IDENTIFY potential impacts and DISCLOSE them. Adverse impacts are allowed under NEPA. This sentence implies that any adverse impact would need to be mitigated, which is not required

7 CALPUFF MODELING RESULTS AND ANALYSIS

7.1. Introduction

The purpose of AQRV modeling is to ensure that Class I area resources (i.e., visibility, flora, fauna, etc.) are not adversely affected by the projected emissions from a proposed project. AQRV's are resources which may be adversely affected by a change in air quality. Based on its proximity to the Wind Cave National Park, a federally mandated Class I area, the Dewey-Burdock Project was modeled to determine its potential AQRV impacts at Wind Cave. Species modeled included PM_{10}, $PM_{2.5}$, SO_2, NO_x, SO_4, $NHNO_3$ and NO_3. The first four of these would be emitted by the project, while the other three ~~were based on reaction chemistry~~ in the atmosphere.

The model selected for AQRV impact analysis (recommended by EPA and the Federal Land Managers) is CALPUFF, along with its companion models CALMET and CALPOST. In addition to the above seven species, elemental carbon (EC) and organic ~~carbon~~ (SOA) were enabled in the model to accommodate Visibilty Method 8.1. Visibility model outputs included daily background light extinction at receptors in Wind Cave National Park, to which the project impacts were added. By contrast, the modeled atmospheric deposition rates were attributable only to project emissons. Background deposition rates and significance thresholds were obtained from sources outside the model.

The CALPUFF modeling domain was selected to include the project area, Wind Cave National Park, and a 50-km buffer to provide meteorological model continuity. This resulted in a 200-km by 200-km modeling grid (Figure 7-1). A total of 192 model receptor locations were obtained for Wind Cave from the National Park Service (Figure 7-2). Modeled emission sources and emission rates were identical to those configured in the AERMOD model (Figure 7-3).

Visibility impacts from the Dewey-Burdock Project at Wind Cave were modeled under two scenarios. The first one included coarse particulate matter (PM_{10}) in computing total light extinction, which resulted in a 98th percentile of 24-hour changes in visibility (relative to background) of 3.5%. This level of change in visibility is less than the 5% change considered barely perceptible by 50% of the viewers. The second scenario excluded PM_{10} from this computation, resulting in a 98th percentile of 24-hour changes

The NPS is likely to dispute an approach that omits PM10.

in visibility of 1.1%, well below the 5% threshold. Section 7.2 presents evidence and precedent for the validity of the second scenario, due to CALPUFF's lack of accounting for deposition of most PM_{10} particles within a short distance of the emission source.

Atmospheric deposition (also known as acid deposition), another measure of AQRV impact, is modeled by CALPUFF as the deposition of a variety of species containing nitrogen and sulfur. SO_2 and NO_x emissions from the Dewey-Burdock Project constitute potential sources of acid deposition at Wind Cave National Park. The modeled deposition rates predicted by CALPUFF were first compared to measured deposition rates at Wind Cave. Second, the modeled deposition rates were compared to estimated critical loads at Wind Cave, below which no harmful impacts to the ecosystem would be expected to occur. Third, the modeled deposition rates were compared to the deposition analysis thresholds established by the U.S. Forest Service, below which deposition impacts are considered negligible. Section 7.3 presents these comparisons and predicts that annual deposition impacts from the Dewey-Burdock Project will be less than the deposition analysis thresholds for nitrogen and sulfur by an order of magnitude. This section also shows that historical deposition rates are substantially lower than the estimated critical loads for both sulfur and nitrogen.

Figure 7-1. CALPUFF Modeling Domain

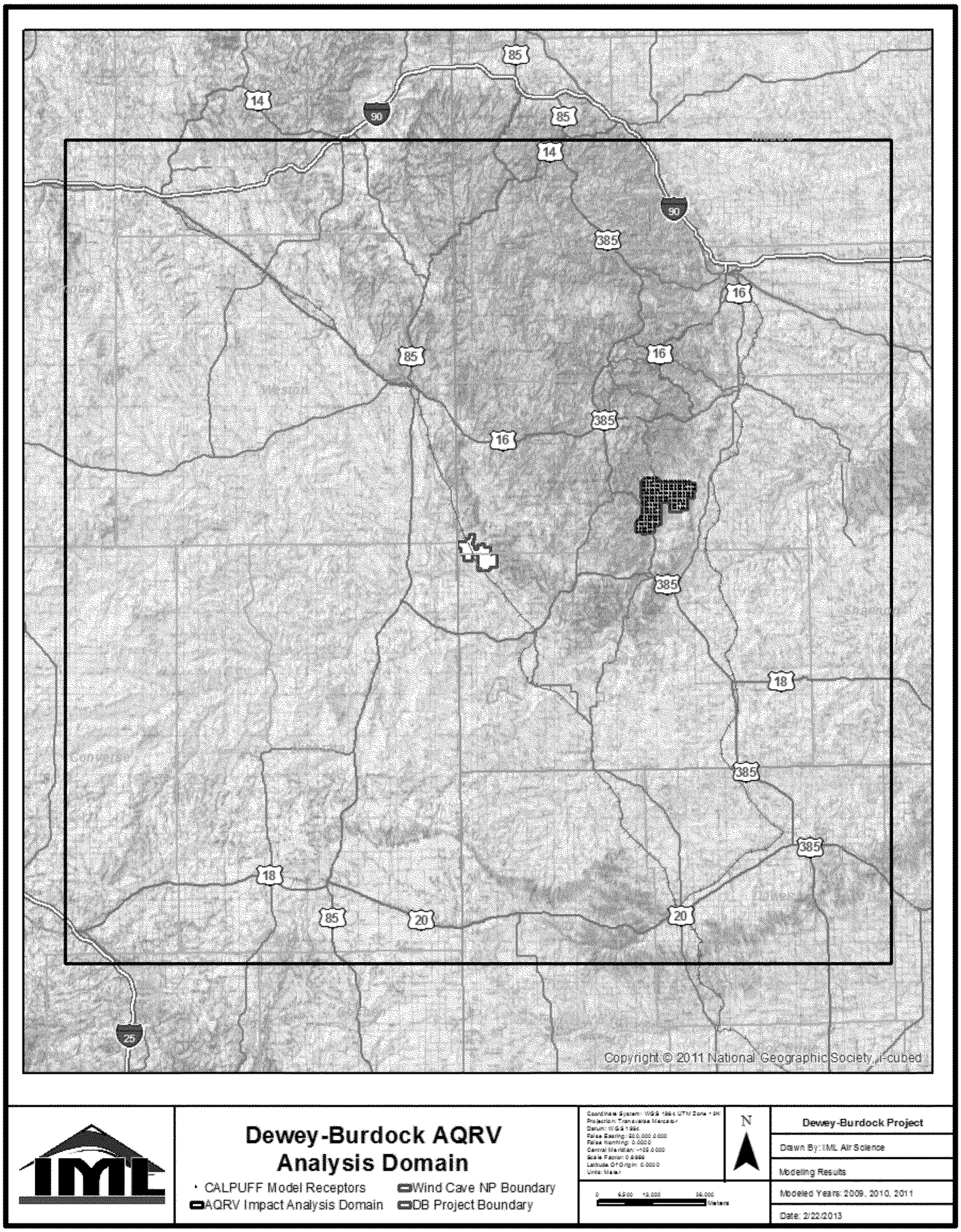


Figure 7-2. CALPUFF Model Receptors

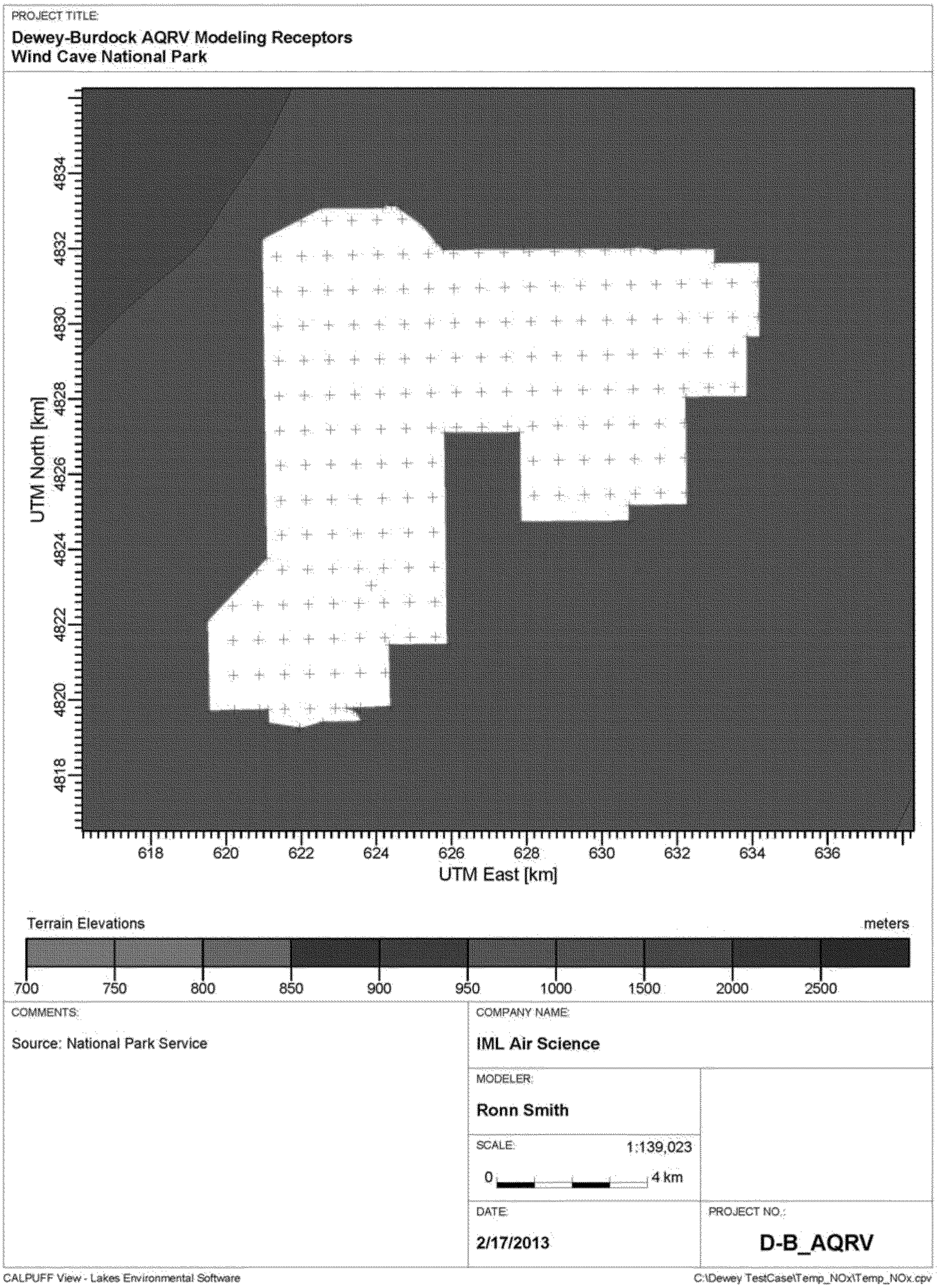
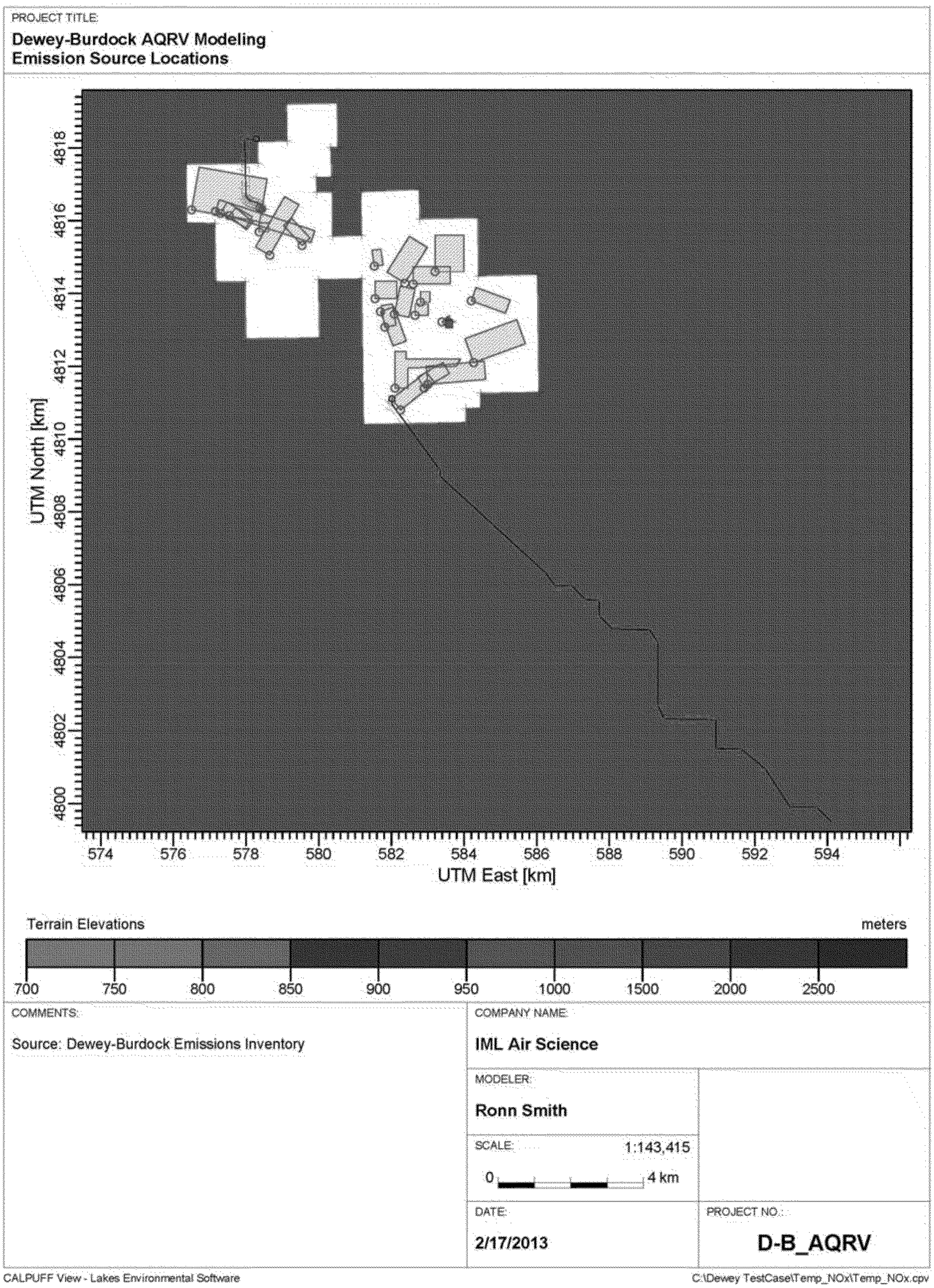


Figure 7-3. CALPUFF Modeled Emission Sources



7.2. Visibility Analysis

7.2.1. Basis for Analysis

In August 1977, the federal Clean Air Act was amended by Congress to establish the following national goal for visibility protection:

> "Congress hereby declares as a national goal the prevention of any future, and the remedying of any existing, impairment of visibility in mandatory class I Federal areas which impairment results from man-made air pollution."

To address this goal for each of the 156 mandatory federal Class I areas across the nation, the ~~federal~~ Environmental Protection Agency (EPA) developed regulations to reduce the impact of large industrial sources on nearby Class I areas. ~~It was recognized at the time that regional haze, which comes from a wide variety of sources that may be located far from a Class I area, was also a part of the visibility problem.~~

The 1977 Clean Air Act Amendments also established the Prevention of Significant Deterioration (PSD) permit program, which included consultation with federal land managers on visibility impacts and public participation in permitting decisions. The PSD permit program was delegated to South Dakota on July 6, 1994, and later approved in South Dakota's State Implementation Plan on January 22, 2008.

In 1980, EPA adopted regulations to address "reasonably attributable visibility impairment", or visibility impairment caused by one or a small group of man-made sources generally located in close proximity to a specific Class I area. Most visibility impairment occurs when pollution in the form of small particles scatters or absorbs light. Air pollutants are emitted from a variety of natural and anthropogenic sources. Natural sources can include windblown dust and smoke from wildfires. Anthropogenic sources can include motor vehicles, electric utility and industrial fuel burning, prescribed burning, and mining operations. More pollutants mean more absorption and scattering of light, which reduce the clarity and color of scenery. Some types of particles such as sulfates and nitrates scatter more light, particularly during humid conditions. Other particles like elemental carbon from combustion processes are highly efficient at absorbing light.

This sentence is too generic and not necessarily true. Visibility has been improving in many Class I areas over the last decade.

Part of this sentence is redundant with the next paragraph, and the second part is problematic because many FLMs do not agree with it.

Commonly, visibility is observed by the human eye ~~and the object may be a sir~~ viewing target or scenery. ~~In the 156 Class I areas across the nation, a person'~~ ~~range has been substantially reduced by air pollution over the past few decade~~ common measure of visual resources is the haze index, expressed in ~~deciview~~ The deciview is a metric used to represent ~~normalized~~ light extinction attributab visibility-affecting pollutants. ~~A 0.5 dv change equals about a 5% change in visi~~ ~~and is barely perceptible by about 50% of the observers.~~

~~For sources generally further than 50 km from a Class I area, t~~he visibility threshold of concern is not exceeded if the 98th percentile change in light extinction is less than 5% for each year modeled, when compared to the annual average natural condition value for that Class I area (FLAG 2010). A 5% change in light extinction is equivalent to a 0.5 dv change in visibility. When assessing visibility impairment from regional haze, EPA guidelines indicate that for a source whose 98th percentile value of the haze index, evaluated on a 24-hour average basis, is greater than 0.5 dv is considered to contribute to regional haze visibility impairment.

7.2.2. Preliminary Modeled Visibility Impacts

Wind Cave National Park, located approximately 50 km east-northeast of the proposed Dewey-Burdock Project, is the nearest Class I area and the only one in the modeling domain. The maximum potential air emissions from the project were modeled for impacts on visibility at Wind Cave, using the CALPUFF software and modeling protocol discussed in Section 5 of this report. The modeling results, with and without consideration of coarse particulate matter (PM_{10}) emissions from the Dewey-Burdock Project, are summarized in Table 7-1. Project emissions of fine particulate matter ($PM_{2.5}$) were included in both model runs, along with oxides of nitrogen and sulfur. These three species, along with organic carbon, are the primary contributors to visibility impairment in the Wind Cave region (DENR 2010).

I strongly suggest that comparisons to a 1.0 dv change be deleted from this table and all discussion. The NPS uses 0.5 dv, which is documented in FLAG.

Table 7-1: Visibility Analysis Summary

Scenario	Statistic	3-Year	Significance Threshold	1st Year	2nd Year	3rd Year
Modeled With Coarse Particulate	98th pctile Δdv	0.35	0.50	0.33	0.31	0.40
	#Days > 0.5 Δdv	11	--	3	4	4
	#Days > 1.0 Δdv	0	--	0	0	0
	Maximum Δdv	0.83	--	0.55	0.83	0.58
Modeled Without Coarse Particulate	98th pctile Δdv	0.11	0.50	0.10	0.11	0.12
	#Days > 0.5 Δdv	0	[illegible]	[illegible]	[illegible]	[illegible]
	#Days > 1.0 Δdv	0	[illegible]	[illegible]	[illegible]	[illegible]
	Maximum Δdv	0.20	[illegible]	[illegible]	[illegible]	[illegible]

This section heading needs to be revised. The NRC and BLM should not be taking on the role of EPA, by appearing to evaluate "model weaknesses". A better heading may be "Effect of Coarse Particulate on CALPUFF Visibility Assessment.

7.2.3. CALPUFF Visibility Model Weakness

There is evidence and precedent that supports excluding ground-level, fugitive PM_{10} emissions from the assessment of project impacts on visibility at Wind Cave (see discussion below). Even without this exclusion, however, Table 7-1 shows the 98th percentile of the annual, 24-hour average changes in haze index to be less than the contribution threshold of 0.5 dv. With the PM_{10} exclusion, the modeled Δdv values fall well below this threshold.

A recent EIS for a gas development in southern Wyoming discussed the exclusion of fugitive PM_{10} emissions from visibility assessment (TRC 2006). Appendix F to the EIS states, “In post-processing the PM_{10} impacts at all far-field receptor locations, the PM_{10} impacts from Project alternative traffic emissions (production and construction) were not included in the total estimated impacts, only the $PM_{2.5}$ impacts were considered. This assumption was based on supporting documentation from the Western Regional Air Partnership (WRAP) analyses of mechanically generated fugitive dust emissions that suggest that particles larger than $PM_{2.5}$ tend to deposit out rapidly near the emissions source and do not transport over long distances (Countess et al. 2001). This phenomenon is not modeled adequately in CALPUFF; therefore, to avoid overestimates of PM_{10} impacts at far-field locations, these sources were not considered in the total modeled impacts. However, the total PM_{10} impacts from traffic emissions were included in all in-field concentration estimates.”

"Traffic emissions" are are mechanically generated. Do you mean vehicle exhaust emissions?

Deposition is recognized as an important effect that can lead to rapid concentration depletion in a fugitive PM_{10} emissions plume generated at or near ground level. Physical measurements reported by the South Dakota Department of Natural Resources (DENR) and the Western Regional Air Partnership (WRAP) conclude that coarse mass particulates (i.e., PM_{10} and larger) contribute a small fraction toward visibility impairment at Wind Cave. DENR's Regional Haze State Implementation Plan states, "In the 1st quarter, ammonia sulfate and ammonia nitrate have the greatest impact on visibility impairment in the Wind Cave National Park. In the 2nd quarter, ammonia sulfate has the greatest impact on visibility impairment in the Wind Cave National Park in the last five years. In the 3rd quarter, organic carbon mass has the greatest impact on visibility impairment followed by ammonia sulfate. In the 4th quarter, ammonia sulfates and ammonia nitrate continue to contribute the greatest with one exception in 2005" (DENR 2010). In 2005, organic carbon dominated due to wild fires.

Despite the above findings and the fact that virtually all of the PM_{10} emissions from the Dewey-Burdock Project would be ground-level fugitive dust, initial CALPUFF modeling results showed PM_{10} emissions to be dominant in determining changes in visibility at Wind Cave. On days with non-zero Δdv values, CALPUFF attributed on average about 70% of the change in visibility to PM_{10} emissions. Removing PM_{10} from the visibility analysis, as allowed for in the CALPUFF post-processor CALPOST, lowered these Δdv values proportionately.

To confirm the validity of excluding fugitive PM_{10} emissions from the visibility assessment, three test receptors were evaluated with CALPUFF. One was placed 80km east of the Dewey-Burdock Project and another 117 km northeast of the project, both near the edge of the modeling domain. At these large distances one would expect a diminished role for coarse particulate emissions from the project, in affecting overall visibility. A third receptor was placed near Wind Cave National Park as a control. CALPUFF was rerun with these test receptors, followed by post-processing in CALPOST with and without the PM_{10} option enabled. The results allowed the computation of that portion of Δdv attributable to PM_{10}, as shown in Table 7-2.

Table 7-2: Model Comparison Test, Coarse PM Contribution to Δdv

Receptor	Easting	Northing	Average PM_{10} Contribution	Distance from Source (km)
1	660,000	4,815,000	64%	80
2	660,000	4,900,000	75%	117
3	620,000	4,820,000	62%	40

7.2.4. Final Modeled Visibility Impacts

Table 7-2 illustrates that not only is PM_{10} the dominant contributor to modeled changes in visibility even at distant locations, but in this scenario its contribution actually increases with distance from the emission source. This runs counter to common sense, and ~~confirms the inadequacy of~~ CALPUFF's ~~long-range transport model to properly account for~~ PM_{10} deposition near the source. For this reason the visibility modeling results that exclude PM_{10} are presented here ~~as the most representative of potential project impacts. The initial CALPUFF results are presented for disclosure purposes~~.

one-fifth (based on 98th percentile)

As shown in Table 7-1, the impacts without coarse particulate matter are approximately one fourth the 0.5 dv threshold of concern, or significance level. There were no days during the modeled three-year period with Δdv over the significance level. The maximum 24-hr Δdv was 0.20 dv.

Add similar description of results with coarse PM.

The deciview haze index is derived from calculated light extinction measurements so that uniform changes in haziness correspond to uniform incremental changes in perception across the entire range of conditions, from pristine to highly impaired. The deciview haze index is calculated directly from the total light extinction coefficient (b_{ext} expressed in inverse megameters [Mm^{-1}]) as follows:

$$dv = 10 \ln (b_{ext}/10\ Mm^{-1})$$

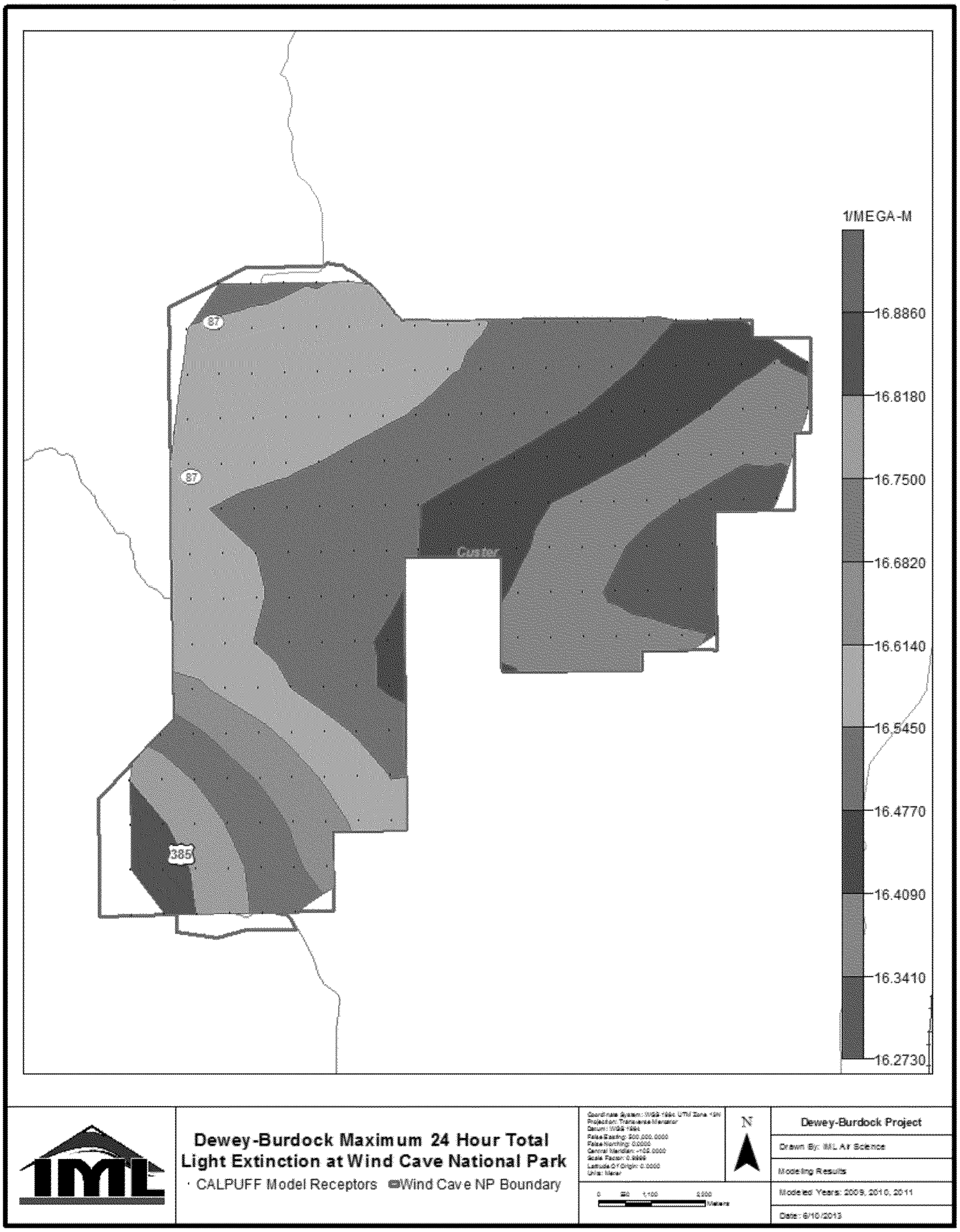
CALPOST produced maximum 24-hour light extinction values for each model receptor at Wind Cave National Park. The highest 24-hr total b_{ext} was 16.0 Mm^{-1}. The corresponding background extinction on that day (without Dewey-Burdock Project light extintion?

impacts) was 15.5 Mm^{-1}, leading to the 0.20 dv change in the haze index reported above.

With coarse particulate matter included in the visibility analysis, CALPUFF predicts the maximum change in haze index to be 0.83 dv. ~~Figure 7-4 is a contour map of maximum total light extinction modeled at all receptors with PM_{10} included.~~

This figure provides no useful information. Please delete.

Figure 7-4. Wind Cave 3-Yr Maximum 24-hr Light Extinction



ED_005364K_00015601-00102

7.3. Deposition Analysis

A discussion of DATs and comparison of modeled deposition rates to DATs would be sufficient., along with the current acid deposition data I am concerned that all of the critical load discussion focuses on non-NPS data, when the area being analyzed is under the jurisdiction of the NPS FLAG 2010 contains a diagram showing the required deposition analysis steps. DAT analysis is sufficient and avoids the need for critical load information which is not available for Wind Cave NP.

7.3.1. Basis for Analysis

Air pollution emitted from a variety of sourc
Of particular concern are compounds conta
the air into the soil or surface waters. These
such as long-term acidification, soil nutrient
of biodiversity.

~~The term critical load is used to describe the threshold of air pollution deposition that causes harm to sensitive resources in an ecosystem. A critical load is technically defined by the National Atmospheric Deposition Program as "the quantitative estimate of an exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment are not expected to occur according to present knowledge." Critical loads are typically expressed in terms of kilograms per hectare per year (kg/ha/yr) of wet or total (wet + dry) deposition. Critical loads are widely used to set policy for resource protection in Europe and Canada. They are presently emerging as guidelines to help in the protection of Class I areas in the United States. Recommended critical loads for nitrogen alone range from 1.5 kg/ha/yr at sensitive alpine regions such as Rocky Mountain National Park (Fenn 2003), to 8 kg/ha/yr at Mt. Rainier, to 10-25 kg/ha/yr in mixed and short-grass prairie systems (USFS 2010).~~

~~Due to the lower elevation and absence of lakes with low acid buffering capacity at Wind Cave and throughout the northern Great Plains, it is believed that conditions in Wisconsin and Minnesota are more representative than conditions in the Rocky Mountains. Based on the Acid Deposition Control Act passed by Minnesota, the sulfur (S) deposition limit that would protect the most sensitive lakes and streams from acidification was set at 11 kg/ha/yr for the Class I Boundary Waters Canoe Area Wilderness (USFS 2013). Total S plus 20% of nitrogen (N) deposition was set at 12 kg/ha/yr, implying a critical load for N of 5 kg/ha/yr. The Forest Service shows similar thresholds for the Rainbow Lake Wilderness in Wisconsin (7.5 kg/ha/yr each, for S and N). The combined critical loads (S + N) of 17 kg/ha/yr in Minnesota and 15 kg/ha/yr in Wisconsin are consistent with the 10-to-25 kg/hr/yr range cited above for N in mixed and short-grass prairie systems.~~

~~Another measure often applied to sulfur and nitrogen deposition is the~~ Deposition Analysis Threshold~~, or~~ concern threshold, below which estimated impacts from a source are considered negligible. ~~In the Class I areas of Colorado, Wyoming and Montana where high mountain lakes often exhibit low acid neutralization capacity, [...] has been set by the U.S. Forest Service at 0.005 kg/ha/yr for sulfur and nitrogen. In Wisconsin and Minnesota, the Class I thresholds are 0.010 [...] date, no concern threshold has been published for Class I areas in Sou[...] the 0.010 kg/ha/yr value appears representative.~~

~~I consider Wind~~ Cave NP to be located in a western area since it is well west of the Mississippi River and is located at relatively high elevation (~4000 ft).

7.3.2. Modeled Deposition Fluxes

~~In order to assess potential impacts of the Dewey-Burdock Project on atmospheric deposition at Wind Cave National Park, it is necessary to examine current conditions.~~ Table 7-4 summarizes ~~actual measurements of precipitation chemistry~~ at Wind Cave for the modeled years. Samples were collected and analyzed under the National Acid Deposition Program (NADP 2012). The combined (S + N) deposition rate or flux averaged just over 4 kg/ha/yr during the three-year period.

Table 7-3: Current Acid Deposition at Wind Cave National Park (kg/ha/yr)

Year	NH4	NO3	SO4	S (inferred)	N (inferred)	S + N
2009	2.14	4.68	3.00	1.00	2.72	3.72
2010	3.04	5.29	3.48	1.16	3.56	4.72
2011	2.30	4.78	2.70	0.90	2.87	3.77
Average				**1.02**	**3.05**	**4.07**

Source: National Atmospheric Deposition Program/National Trends Network, 2012

Table 7-5 presents the results of wet and dry deposition modeling of the Dewey-Burdock Project emissions using CALPUFF. The table compares these results to measured values~~, concern thresholds and critical loads~~.

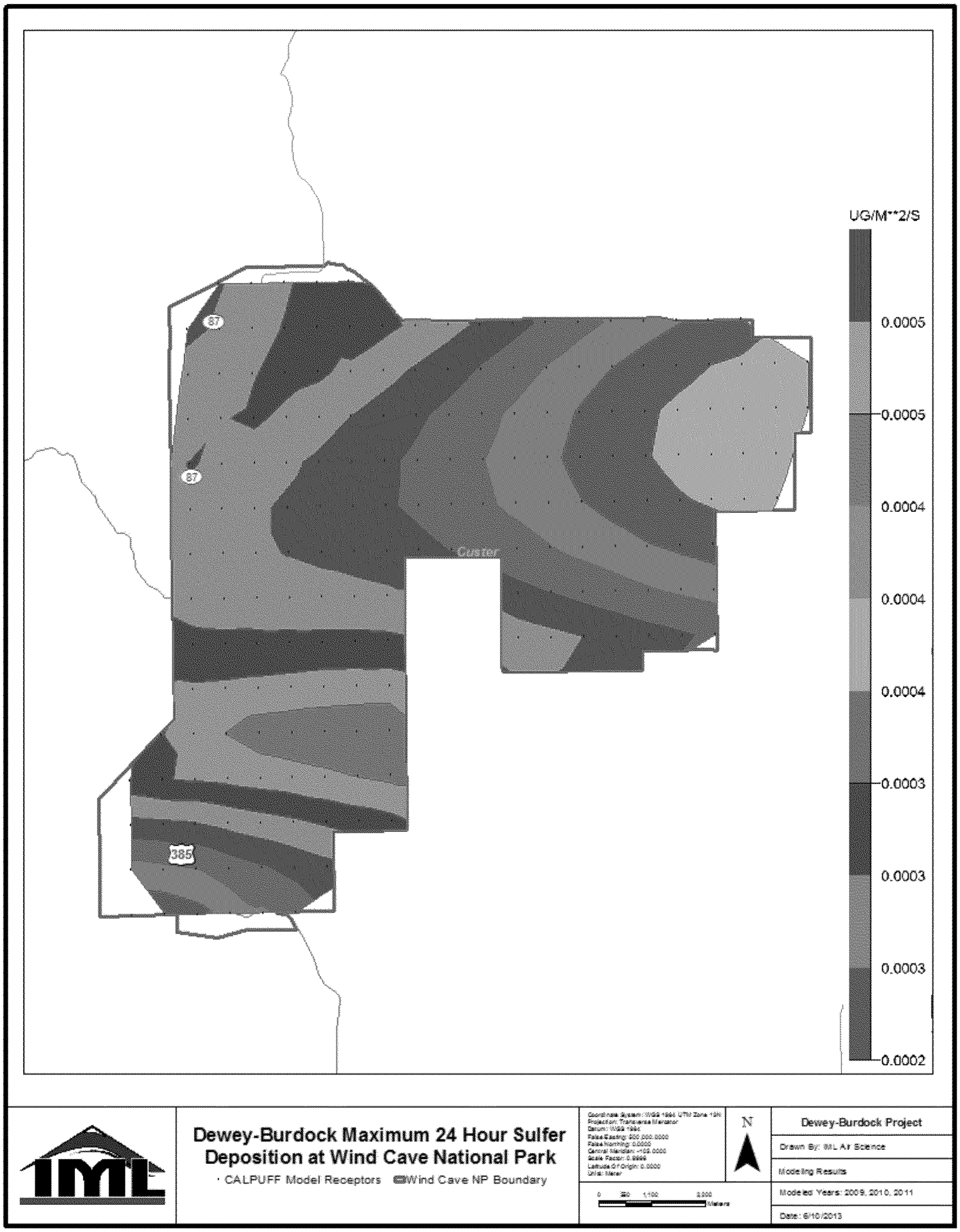
Table 7-4: Acid Deposition Modeling Analysis at Wind Cave (Wet + Dry, kg/ha/yr)

Parameter	Sulfur	Nitrogen	Sulfur + Nitrogen
Modeled daily maximum µg/m^2/sec	0.0005188	0.0008392	0.0013580
Modeled 3-yr average µg/m^2/sec	0.0000031	0.0000051	0.0000083
Modeled 3-yr average kg/ha/yr	0.0010	0.0016	0.0026
~~Concern threshold~~ (kg/ha/yr)	0.0~~10~~	0.010	0.0~~20~~
Measured 3-yr average kg/ha/yr	1.02	3.05	4.07
~~Estimated critical load (kg/ha/yr)~~	~~12~~	~~5~~	~~17~~

~~First, Table 7-5 shows that measured deposition flux for S and N are less than the estimated critical loads, by a significant margin. Second,~~ Table 7-5 predicts that annual deposition impacts from the Dewey-Burdock Project will be less than the concern thresholds~~ by an order of magnitude~~. Also listed are the predicted, peak 24-hr deposition rates, in µg/m^2/sec. ~~Figures 7-5 and 7-6 provide contour plots of the modeled maximum 24-hour S deposition and N deposition fluxes, respectively.~~

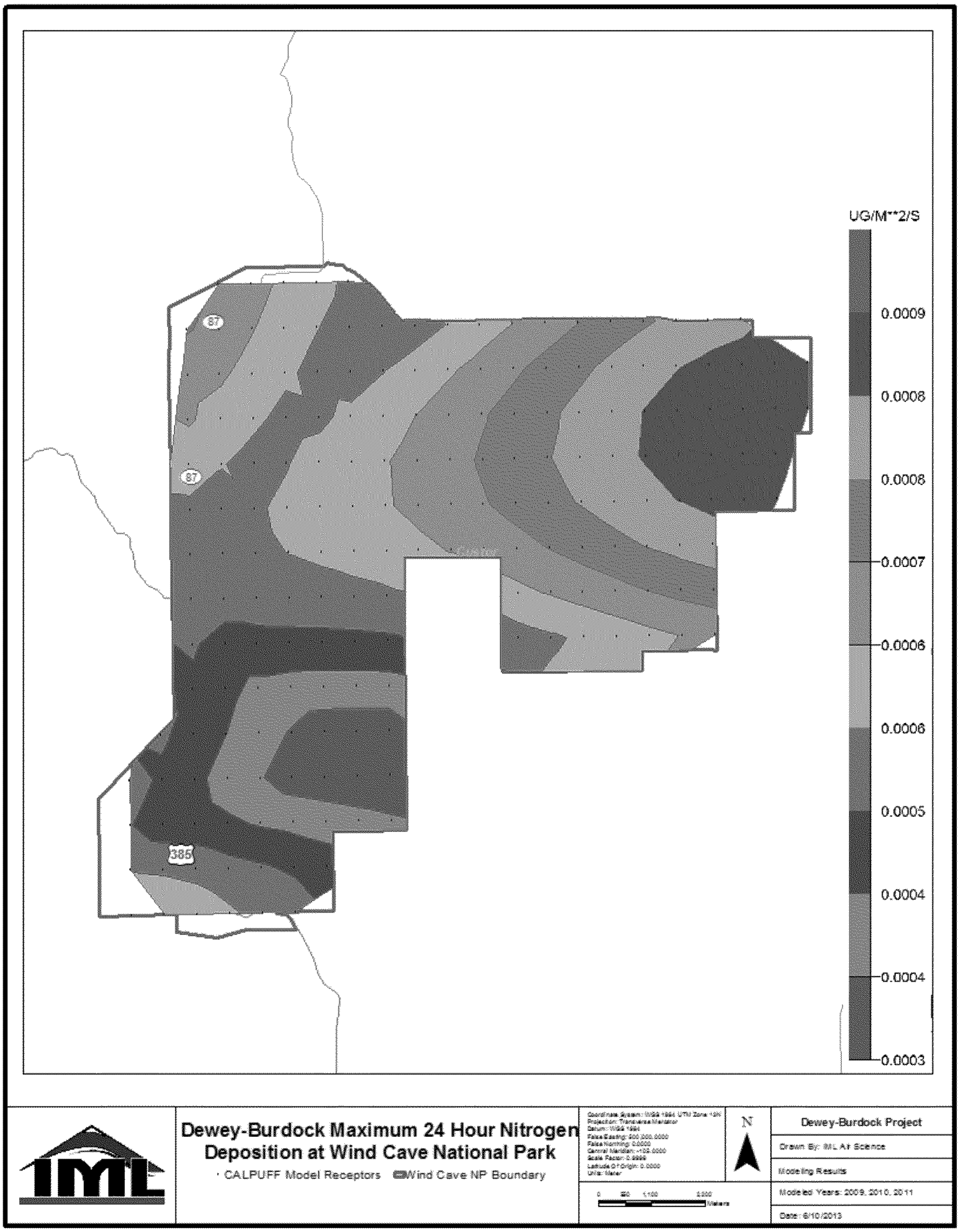
This figure provides no useful information. Please delete.

Figure 7-5. Maximum 24-hr Sulfur Deposition Rates at Wind Cave National Park



This figure provides no useful information. Please delete.

Figure 7-6. Maximum 24-hr Nitrogen Deposition Rates at Wind Cave National Park



ED_005364K_00015601-00107

8 REFERENCES

1. AECOM 2012, Robert Paine and David Heinold, AECOM, *Modeling Issues for Short-Term SO_2, NO_2, and $PM_{2.5}$ NAAQS Compliance*, Air & Waste Management Association 105th Annual Meeting and Exhibition, June 21, 2012.
2. ANL 2013, Argonne National Laboratory, Soil Density, http://web.ead.anl.gov/resrad/datacoll/soildens.htm
3. BLM 2010, *Draft Environmental Impact Statement, Appendix K. Air Resources Impact Assessment Technical Report For The Alton Coal Lease By Application*, September 2010.
4. Cliffs 2011, Michael E. Long, Director Environmental Strategy and Programs, Cliffs Natural Resources, *Air Quality Modeling and Impacts on the Mining Industry: An Overview*, September 26, 2011.
5. Countess 2001, *Methodology For Estimating Fugitive Windblown And Mechanically Resuspended Road Dust Emissions Applicable For Regional Scale Air Quality Modeling*; April 2001
6. DENR 2010, South Dakota Department of Natural Resources, *South Dakota's Regional Haze State Implementation Plan*, January 2010.
7. EPA 2013, Ron Meyers, Office of Air Quality Planning and Standards, Sector Policy and Programs Division, Measurement Policy Group, Personal Communication; May 2, 2013.
8. EPA 2012, *Haul Road Workgroup Final Report Submission to EPA-QAQPS*, March 2, 2012
9. EPA 2009, *Reassessment of the Interagency Workgroup on Air Quality Modeling (IWAQM) Phase 2 Summary Report: Revisions to Phase 2 Recommendations, Draft Report*, May 2009.
10. EPA 2005, USEPA, 40 CFR Part 51, *Revision to the Guideline on Air Quality Models: Adoption of a Preferred General Purpose (Flat and Complex Terrain) Dispersion Model and Other Revisions*, November 9, 2005.
11. EPA 2004a, EPA, *Exhaust and Crankcase Emission Factors for Non-Road Engine Modeling - Compression Ignition*, April 2004.
12. EPA 2004b, *Addendum, User's Guide for the AMS/EPA Regulatory Model – AERMOD*, September 2004.
13. EPA 2000, EPA, *Meteorological Monitoring Guidance for Regulatory Modeling Applications*, February 2000.

14. EPA 1998, EPA, *Control of Emissions of Air Pollution from Non-Road Diesel Engines; Final Rule, Subpart 89.112*, October 1998.
15. EPA 1994a, *Development and Testing of a Dry Deposition Algorithm (Revised)*, Publication #EPA-454/R-94-015; April, 1994
16. EPA 1994b, *Modeling Fugitive Dust Impacts from Surface Coal Mining Operations, Phase II, Model Evaluation Protocol*; October, 1994
17. EPA 1995a, *User's Guide for the ISC3 Dispersion Models, Volume II*; September 1995
18. EPA 1995b, *Modeling Fugitive Dust Impacts from Surface Coal Mining Operations, Phase III, Evaluating Model Performance*; December, 1995
19. EPA 1995c, AP 42, Fifth Edition, *Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources*, 1995 (multiple updates through 2012), http://www.epa.gov/ttn/chief/ap42/
20. EPA 1992, EPA Region 10, *User's Guide for the Fugitive Dust Model (FDM) (Revised)*, Volume I: User's Instructions; Sept 1992
21. Fenn 2003, Fenn, Mark E.; Baron, Jill S.; Allen, Edith B.; Rueth, Heather M.; Nydick, Coren R.; Geiser, Linda; Bowman, William D.; Sickman, James O.; Meixner, Thomas; Johnson, Dale W.; Neitlich, Peter, *Ecological Effects of Nitrogen Deposition in the Western United States*, 2003.
22. Fitz 2002, Fitz, D., D. Pankratz, R. Philbrick and G. Li, *Evaluation of the Transport and Deposition of Fugitive Dust using Lidar*, Proceedings, EPA's 11th Annual Emission Inventory Conference, 2002.
23. FLAG 2010, U.S. Forest Service, National Park Service, and U.S. Fish and Wildlife Service. *Federal land managers' air quality related values work group (FLAG): phase I report—revised (2010)*, October 2010.
24. FLAG 2008, U.S. Forest Service, National Park Service, and U.S. Fish and Wildlife Service. 2008. *Federal Land Managers' Air Quality Related Values Workgroup (FLAG). 2008. Phase I Report—Revised. June 2008.*
25. IWAQM 1998, Interagency Workgroup On Air Quality Modeling, *Phase 2 Summary Report And Recommendations For Modeling Long Range Transport Impacts*, December 1998.
26. Majano 2013, Rosendo Majano, Air Quality Modeler, Colorado Department of Public Health and Environment, Personal Communication, May 2013.

27. Maricopa 2006, Maricopa Association of Governments, *Modeling Protocol in Support of a 5 Percent Plan for PM-10 for the Maricopa County Nonattainment Area*, September 2006.
28. MMA 2011, McVehil-Monnett Associates, Inc., *Draft "White Paper," Status of CAAA Section 234, Regulatory and Technical Issues Update*, May 2011.
29. MRI 2006, Midwest Research Institute. *Background Document for Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors*, February 2006.
30. NADP 2012, National Atmospheric Deposition Program, *Annual Data Summary for Site: SD04 (Wind Cave National Park-Elk Mountain)*, 2012. http://nadp.sws.uiuc.edu/nadpdata/ads.asp?site=SD04
31. Nall 2013, Josh Nall, Wyoming Department of Environmental Quality, Air Quality Division, Personal Communication; May 2013
32. New Mexico *2006, New Mexico Air Quality Bureau Air Dispersion Modeling Guidelines*, February 2006
33. NJDEP 2005, New Jersey Department of Environmental Protection, Chromium Work Group, Air Transport Subgroup, Chapter 5, *Public Comment Draft*; March 2005.
34. NRC 2012, *Environmental Impact Statement for the Dewey-Burdock Project in Custer and Fall River Counties, South Dakota*, Supplement to the Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities, Draft Report for Comment, November 2012.
35. Pace 2005, Thompson G. Pace, US EPA, *Methodology to Estimate the Transportable Fraction (TF) of Fugitive Dust Emissions for Regional and Urban Scale Air Quality Analyses*, 8/3/2005 Revision.
36. Rosemont 2009, *Calpuff Modeling Protocol For Rosemont Copper Project To Assess Impacts On Class I Areas*, October 30, 2009.
37. Sullivan 2006, Westbrook, J.A., and Sullivan, P.S., *Fugitive Dust Modeling with AERMOD for PM_{10} Emissions from a Municipal Waste Landfill*, Specialty Conference, 2006.
38. TCEQ 1999, Texas Commission on Environmental Quality, *Texas Air Quality Modeling Guidelines*, New Source Review Permits Division, RG-25 (revised), February 1999.
39. Trinity 2009, Trinity Consultants, *Sensitivity of AERMOD in Modeling Fugitive Dust Emission Sources,* October 28, 2009.

40. Trinity 2007, Arron J. Heinerikson, Abby C. Goodman, Divya Harrison, Mary Pham, Trinity Consultants, *Modeling Fugitive Dust Sources With Aermod*, Revised January 2007.
21. TRC 2006, TRC Environmental Corporation, *Air Quality Technical Support Document, Appendix F to the Atlantic Rim Natural Gas Project and the Seminoe Road Gas Development Project, Wyoming*, July 2006.
22. USFS 2013, USDA Forest Service, Air Resource Management, Boundary Waters Canoe Area Wilderness, *Resource Concern Thresholds*, February 2013. http://www.fs.fed.us/air/technical/class_1/wilds.php?recordID=6
23. USFS 2010, U.S. Forest Service, *Assessment of Nitrogen Deposition Effects and Empirical Critical Loads of Nitrogen for Ecoregions of the United States*, L.H. Pardo, M.J. Robin-Abbott, C.T. Driscoll, editors, February 2010.
24. Watson 1996, J.G. Watson, Desert Research Institute, *Effectiveness Demonstration of Fugitive Dust Control Methods for Public Unpaved Roads and Unpaved Shoulders on Paved Roads*, August 1996.
25. Westbrook, James and Patrick Sullivan, *Fugitive Dust Modeling with AERMOD For PM10 Emissions from a Municipal Waste Landfill*, 2007.
26. WRAP 2006, *CALMET/CALPUFF Protocol for BART Exemption Screening Analysis for Class I Areas in the Western United States*, Prepared for the Western Regional Air Partnership (WRAP) Air Quality Modeling Forum, by Environ, August 2006.

APPENDIX A

EMISSION INVENTORY CALCULATIONS

APPENDIX B

SOURCE APPORTIONMENT AND TIMING

APPENDIX C

BOUNDARY RECEPTOR STUDY

APPENDIX D

WATER TRUCK CONTROL EFFICIENCY

APPENDIX E

AERMOD LIST FILES

APPENDIX F

CALPUFF LIST FILES

APPENDIX G

CALPUFF RESULTS REPORT